Amines and Amides

Chapter 1.7
Amines and Amides

- Amines and amides both contain nitrogen (N)

- An **amine** is an organic compound, related to ammonia, that contains a nitrogen atom bonded to one or more alkyl groups on each molecule.

- An **amide** is an organic compound that contains a carbonyl group bonded to a nitrogen atom.

![Amine structure](image1)

![Amide structure](image2)
Classifying Amines

• Amines can be classified as primary secondary or tertiary
Naming Amines

• Use the suffix –*amine*

• It may be necessary to include a number in the suffix to indicate which carbon group the amine is attached to
Naming Amines

- Secondary and tertiary amines are named using the locator, $N$, to indicate the attachment of additional chains to the nitrogen atom.
Naming Amines

- Sometimes it is necessary to name the amine group as a branch.
- In this case the prefix *amino*- is used.
Properties of Amines

- Amines are polar and some can hydrogen bond
- Amines have higher melting and boiling points than their corresponding alkanes

Can you explain the trend below?

(a) CH₃—CH₂—CH₂—NH₂  
(b) CH₃—CH₂—NH—CH₃  
(c) CH₃—N—CH₃

- Primary amine: b.p. 49 °C
- Secondary amine: b.p. 37 °C
- Tertiary amine: b.p. 3 °C
Properties of Amines

• Small amines are soluble in water
Reactions Involving Amines

• Amines behave as **weak bases** in water

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{N}^+\text{H} & + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{NH}_3^+ \ + \ \text{OH}^- \\
\text{CH}_3\text{CH} & + \text{HCl} \rightarrow \text{CH}_3\text{CH}-\text{NH}_3^+ \ + \ \text{Cl}^-
\end{align*}
\]

• Amines can undergo **neutralization** reactions with acid
Reactions Involving Amines

- **Primary amines** can be synthesized by reacting an alkyl halide with ammonia

  \[
  \text{CH}_3\text{CH}_2\text{I} + \text{H}--\text{N}--\text{H} \rightarrow \text{CH}_3\text{CH}_2--\text{N}--\text{H} + \text{HI}
  \]

  iodoethane          ammonia          ethanamine
  \(1^\circ\) amine  \(1^\circ\) amine  \(1^\circ\) amine

- **Secondary amines** require an alkyl halide and a primary amine

  \[
  \text{CH}_3\text{CH}_2\text{I} + \text{CH}_3\text{CH}_2--\text{N}--\text{H} \rightarrow \text{CH}_3\text{CH}_2--\text{N}--\text{CH}_2\text{CH}_3 + \text{HI}
  \]

  iodoethane          ethanamine          \(N\)-ethylethanamine
  \(1^\circ\) amine  \(1^\circ\) amine  \(2^\circ\) amine

- **Tertiary amines** require an alkyl halide and a secondary amine

  \[
  \text{CH}_3\text{CH}_2\text{I} + \text{CH}_3\text{CH}_2--\text{N}--\text{CH}_2\text{CH}_3 \rightarrow \text{CH}_3\text{CH}_2--\text{N}--\text{CH}_2\text{CH}_3 + \text{HI}
  \]

  iodoethane          \(N\)-ethylethanamine          \(N, N\)-diethylethanamine
  \(1^\circ\) amine  \(2^\circ\) amine  \(3^\circ\) amine
From Amines to Amides

- Amides can be synthesized by the **condensation reaction** of a carboxylic acid with ammonia or a primary or secondary amine.
Naming Amides

- Use the suffix –amide
- Recall that amides are synthesized from the reaction of an amine with a carboxylic acid
  - The first part of the name comes from the amine
  - The second part of the name comes from the carboxylic acid

\[
\text{CH}_3\text{CH}_2\text{CH}_2\text{C} \quad \text{O} \quad \text{H} \quad \text{CH}_3\text{NH} \quad \rightarrow \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{C} \quad \text{O} \quad \text{H} \quad \text{CH}_3 \quad \text{N} \quad \text{CH}_3 + \text{HOH}
\]

butanoic acid  methanamine  \(N\)-methylbutanamide  water

amine  amide
Practice

Name the following:

a) \[
\begin{array}{c}
\text{CH}_3 \text{C} \text{N} \text{CH}_3 \\
\text{H}
\end{array}
\]

b) \[
\begin{array}{c}
\text{CH}_3 \text{N} \text{C} \text{CH}_3
\end{array}
\]

c) \[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2 \text{C} \text{N} \text{CH}_2\text{CH}_3
\end{array}
\]

Draw a structural diagram for:

3-chloro-4-methylpentanamide
Properties of Amides

• Amides are weak bases
• Low molecular weight amides are soluble in water
• Amides that have the ability to hydrogen bond will have higher melting and boiling points
Reactions Involving Amides

- Amides can undergo a **hydrolysis reaction** (the reverse of condensation) to form an amine (or ammonia) and a carboxylic acid.

- This reaction can take place under acidic or basic conditions.

$$R-C-N-R' + H_2O + HCl \rightarrow R-C-OH + H-N^+R'\ Cl^-$$

$$R-C-N-R' + NaOH \rightarrow R-C-O^-Na^+ + H-N-N-R'$$
HOMEWORK

Required Reading:

p. 56-62

Questions:

p. 58 #1-2
p. 60 #1-2
p. 62 #1-6