

4.8: Physical Properties of Amides

Learning Objectives

- Compare the boiling points of amides with alcohols of similar molar mass.
- Compare the solubilities in water of amides of five or fewer carbon atoms with the solubilities of comparable alkanes and alcohols in water.

With the exception of formamide (HCONH_2), which is a liquid, all simple amides are solids (Table 4.8.1). The lower members of the series are soluble in water, with borderline solubility occurring in those that have five or six carbon atoms. Like the esters, solutions of amides in water usually are neutral—neither acidic nor basic.

Table 4.8.1: *Physical Constants of Some Unsubstituted Amides*

Condensed Structure	Name	Melting Point ($^{\circ}\text{C}$)	Boiling Point ($^{\circ}\text{C}$)	Solubility in Water
HCONH_2	formamide	2	193	soluble
CH_3CONH_2	acetamide	82	222	soluble
$\text{CH}_3\text{CH}_2\text{CONH}_2$	propionamide	81	213	soluble
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CONH}_2$	butyramide	115	216	soluble
$\text{C}_6\text{H}_5\text{CONH}_2$	benzamide	132	290	slightly soluble

The amides generally have high boiling points and melting points. These characteristics and their solubility in water result from the polar nature of the amide group and hydrogen bonding (Figure 4.8.1). Similar hydrogen bonding plays a critical role in determining the structure and properties of proteins, deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and other giant molecules so important to life processes.

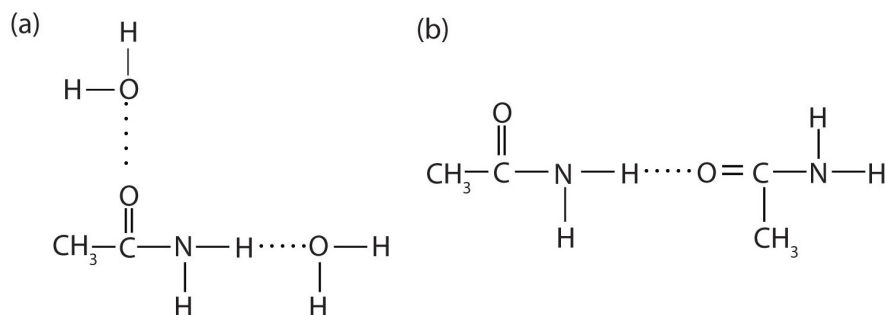


Figure 4.8.1: Hydrogen Bonding in Amides. Amide molecules can engage in hydrogen bonding with water molecules (a). Those amides with a hydrogen atom on the nitrogen atom can also engage in hydrogen bonding (b). Both hydrogen bonding networks extend in all directions.

✓ Example 4.8.1

- Which compound has the higher boiling point—pentanamide or propyl acetate? Explain.
- Which compound is more soluble in water—propanamide or 1-pentene? Explain.

Solution

- Pentanamide ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CONH}_2$) has the higher boiling point because the nitrogen-hydrogen (N-H) and the carbon-oxygen double (C=O) bonds can engage in hydrogen bonding. Propyl acetate ($\text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_3$) cannot engage in hydrogen bonding.
- Propanamide ($\text{CH}_3\text{CH}_2\text{CONH}_2$) is more soluble in water because the N-H and C=O bonds can engage in hydrogen bonding with water. 1-pentene ($\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_3$) cannot engage in hydrogen bonding with water.

? Exercise 4.8.1

- Which compound has the higher boiling point—butyramide or dimethylacetamide $[\text{CH}_3\text{CON}(\text{CH}_3)_2]$? Explain.
- Which compound is more soluble in water—acetamide (CH_3CONH_2) or 1-butene ($\text{CH}_2=\text{CHCH}_2\text{CH}_3$)? Explain.

Key Takeaways

- Most amides are solids at room temperature; the boiling points of amides are much higher than those of alcohols of similar molar mass.
- Amides of five or fewer carbon atoms are soluble in water.

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