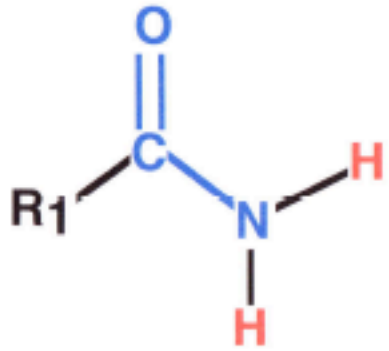
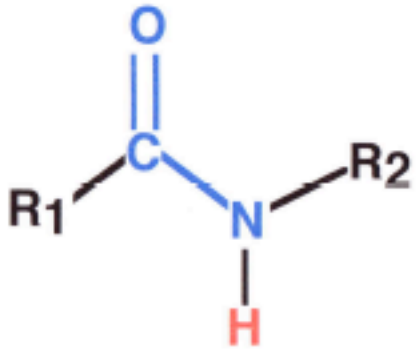
Amides - Structure and Classification

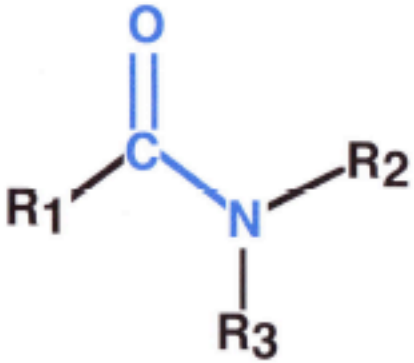
Subclassification



1°



2°

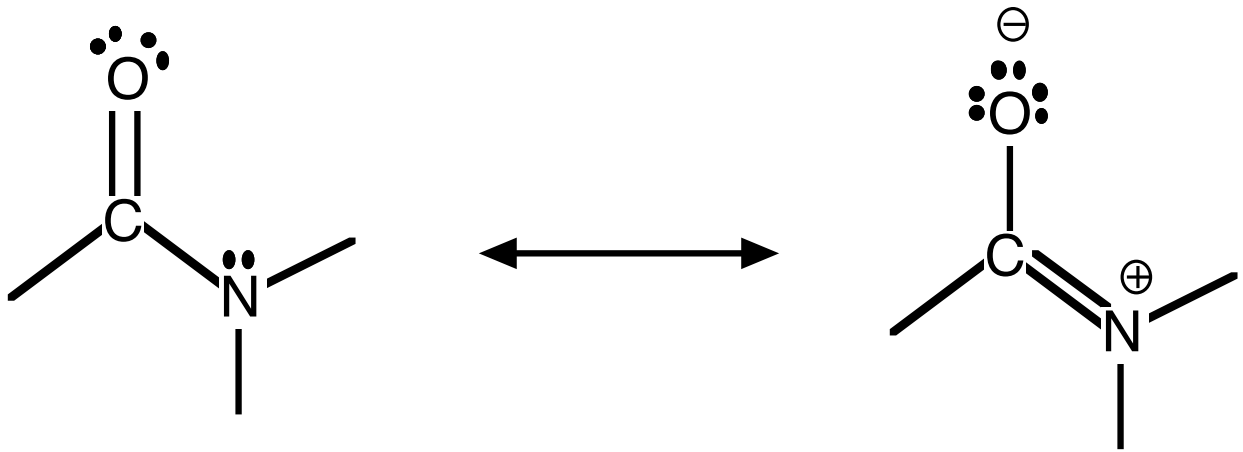


3°

Can amides engage in hydrogen bonding??

Amides - Structure and Classification

The amide is better represented as a dipolar ion:

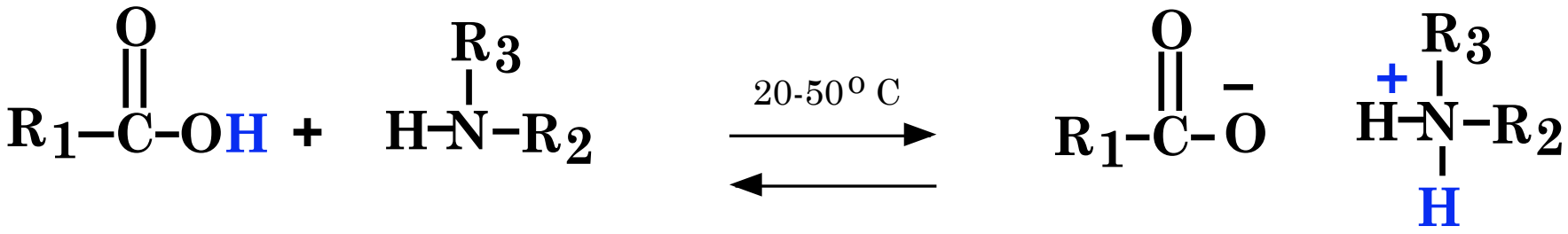


Because the bond between the carbonyl carbon atom and the nitrogen atom has a partial double bond character, the bond angles about the carbonyl carbon atom and nitrogen atom are both close to 120° ***(sp² hybridization)****.*

The dipolar ion nature of the amide bond is very important in determining the structure and function of protein molecules.

Amides - Synthesis

At low temperatures a carboxylic acid and an amine will take part in a simple acid-base reaction to form an ammonium salt.



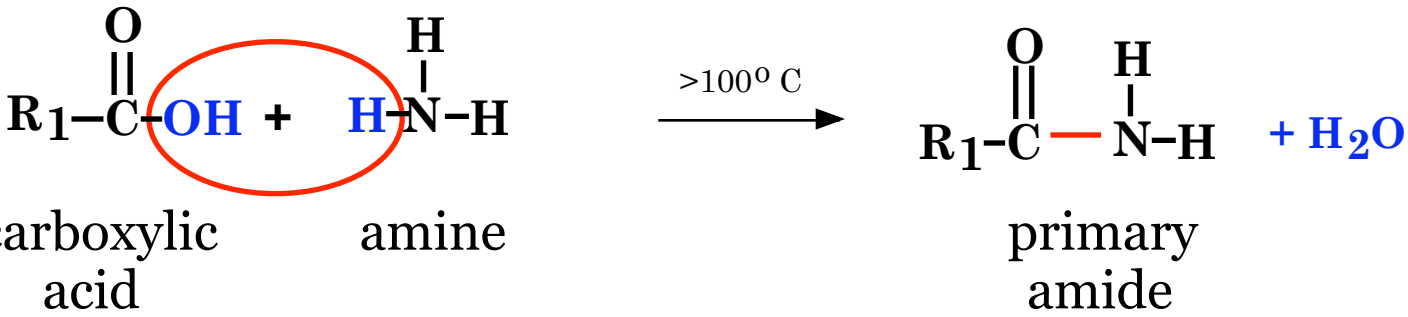
carboxylic acid

amine

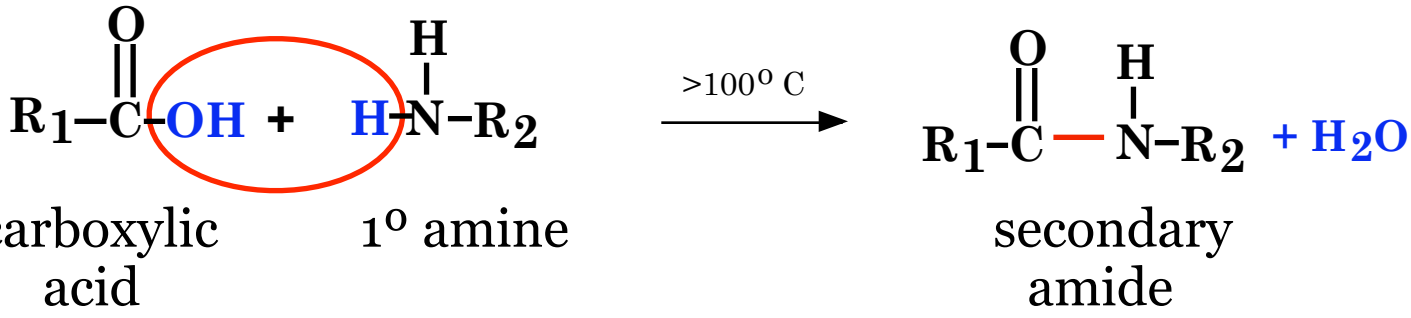
ammonium carboxylate

Amides - Synthesis

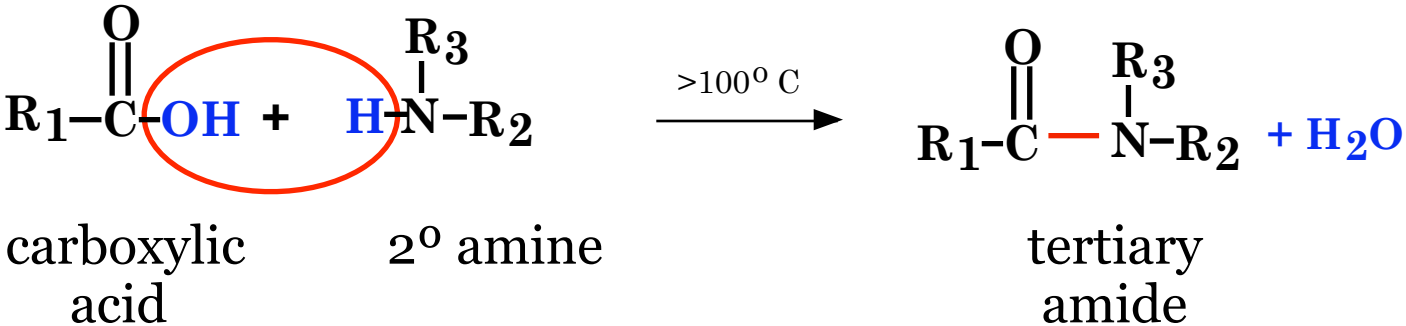
At a higher temperature, a condensation reaction takes place between the carboxylic acid and the amine.



carboxylic acid | amine | primary amide

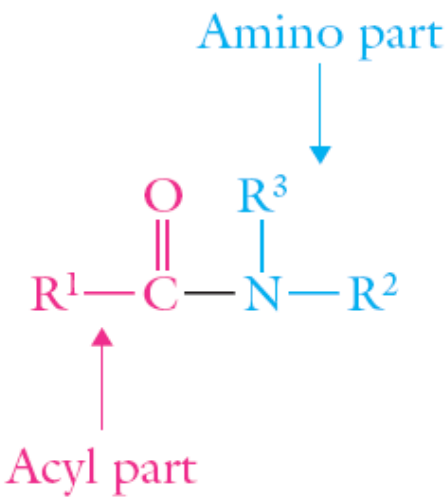


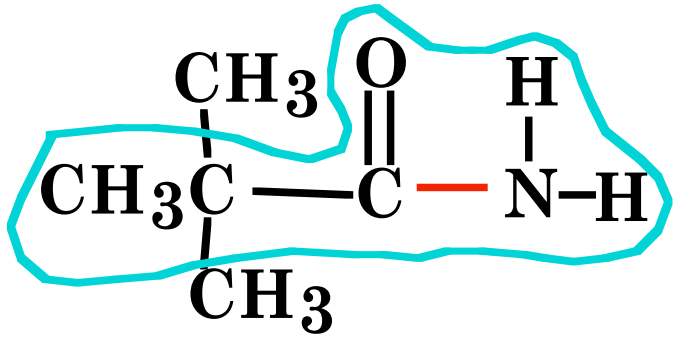
carboxylic acid | 1° amine | secondary amide



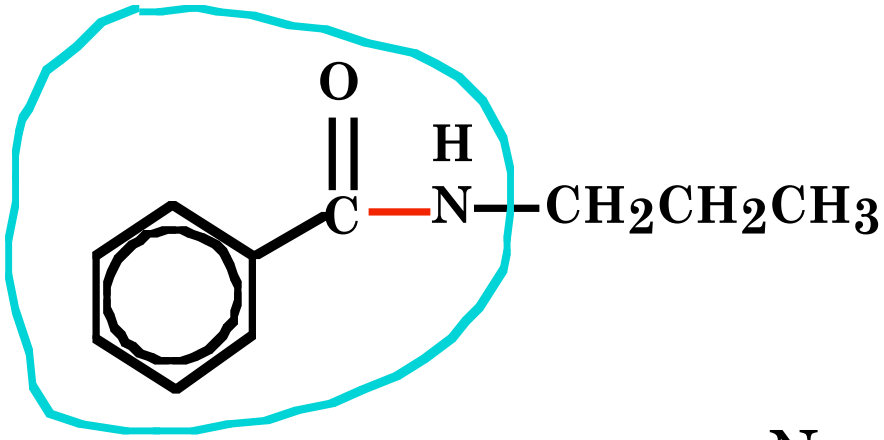
carboxylic acid | 2° amine | tertiary amide

Amides - Nomenclature



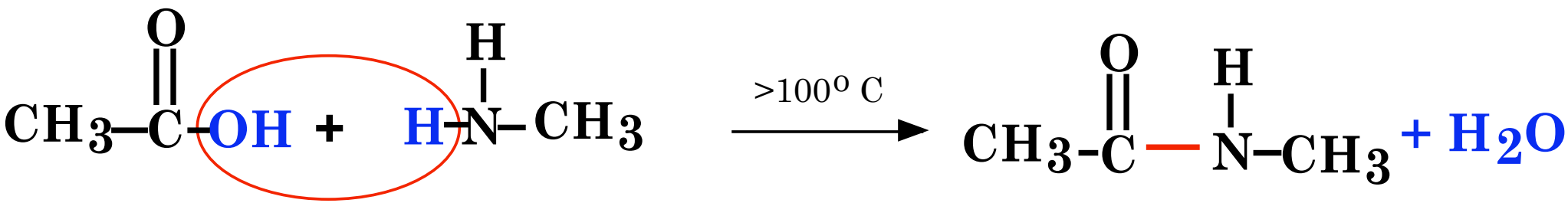


2,2-dimethyl **propanamide**

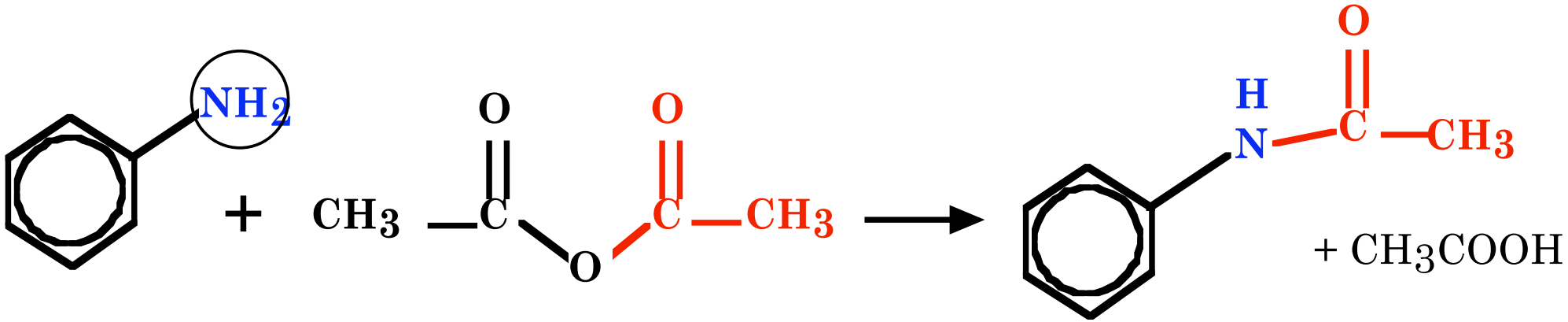


N-propyl **benzamide**

Amides - Synthesis and Nomenclature

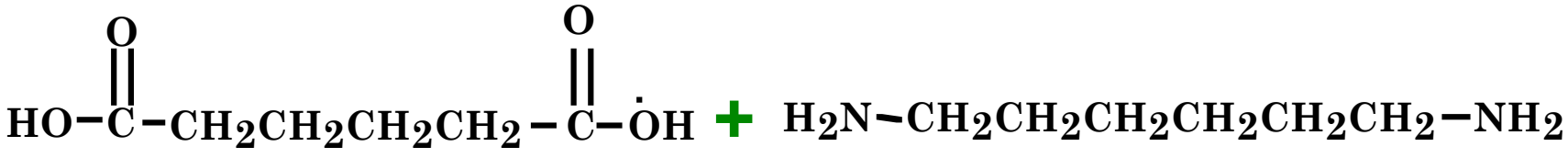


acetic acid methylamine N-methylacetamide



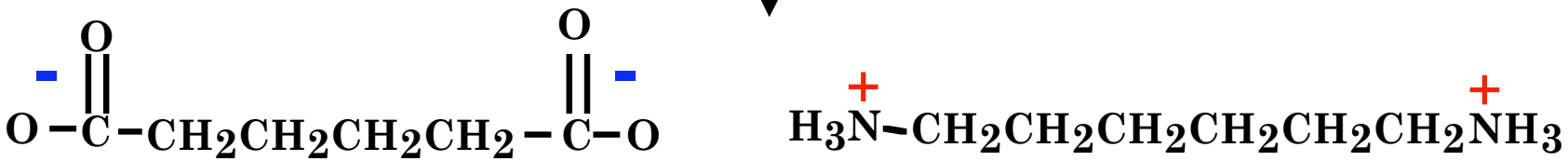
aniline acetic anhydride N-phenyl acetamide acetic acid

Amides - Condensation Polymers



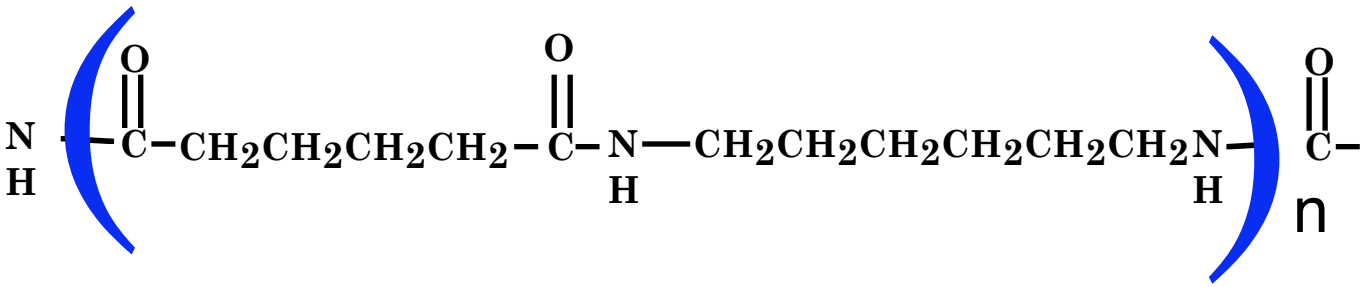
adipic acid + hexamethylene diamine

mix at room temperature



heat

H_2O



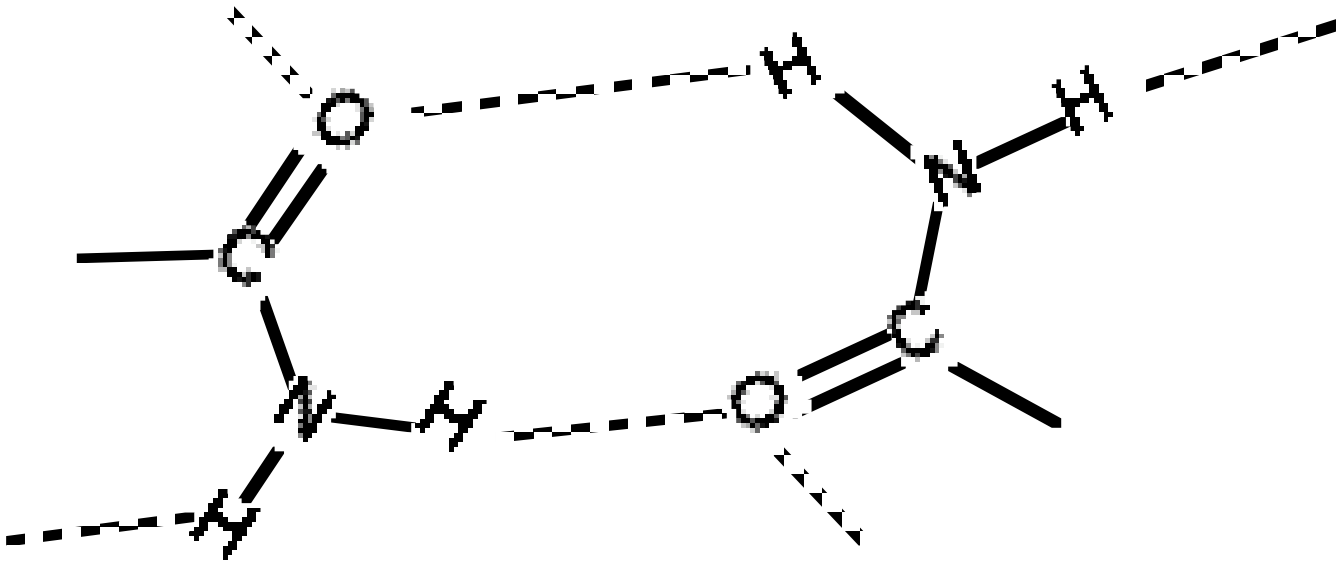
polyhexamethylenediamine adipate

Nylon 6,6

Amides - Physical Properties

Amides have the strongest secondary attractive forces and the highest melting and boiling points of any covalent organic compounds.

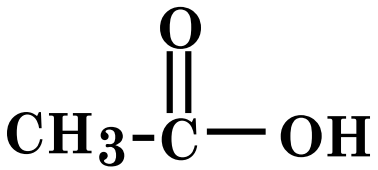
Potential Hydrogen Bonds:



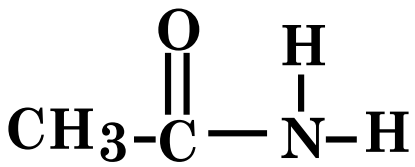
Amides - Physical Properties

Comparison of Carboxylic Acids and Amides

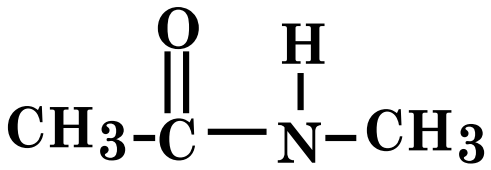
Compound	Structure	Molecular mass (amu)	Melting point (°C)	Boiling point (°C)
acetic acid	CH_3COOH	60	17	118
acetamide	CH_3CONH_2	59	82	221
N-methylacetamide	$CH_3CONHCH_3$	73	28	204
N,*N*-dimethylacetamide	$CH_3CON(CH_3)_2$	87	−20	165



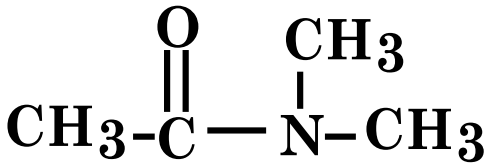
acetic acid



acetamide



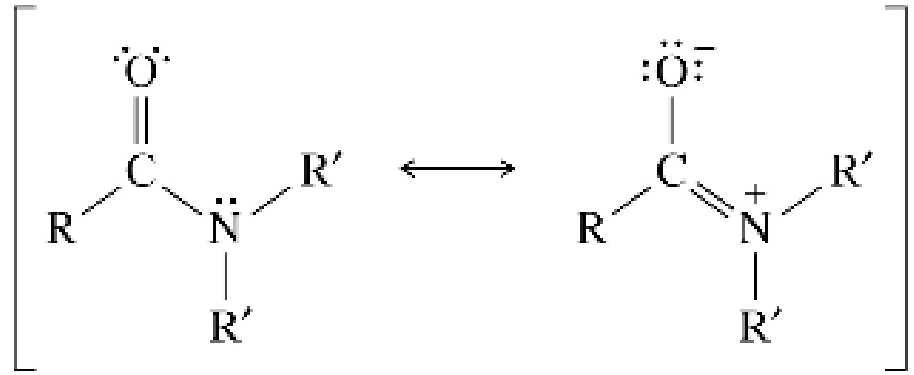
N-methylacetamide

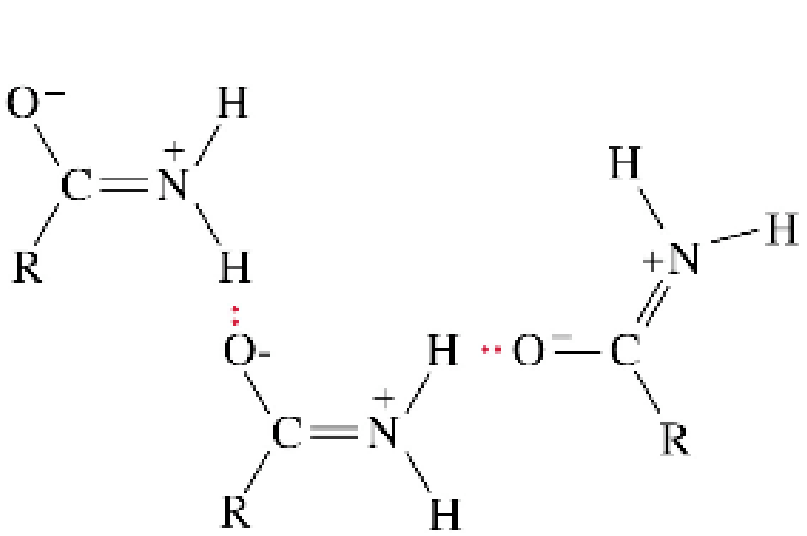


N,N-dimethylacetamide

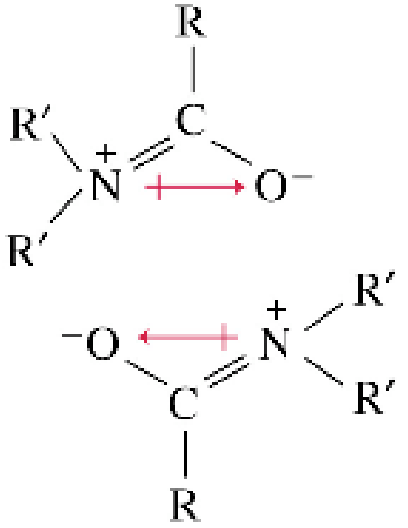
Amides - Physical Properties

The resonance structure of the amide functional group results in a large charge separation in an amide molecule resulting in large polarity and secondary attractive forces.





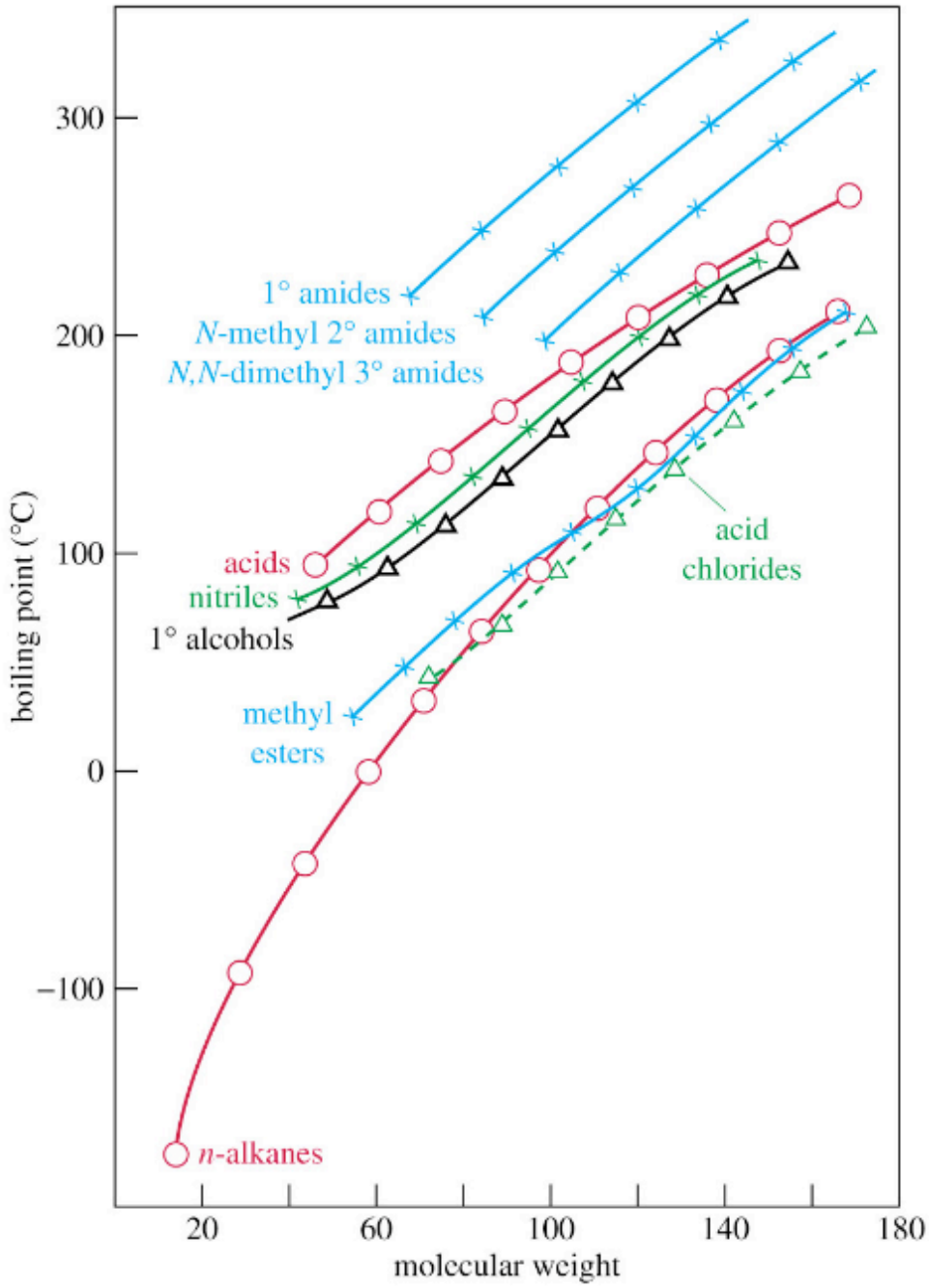
hydrogen bonding



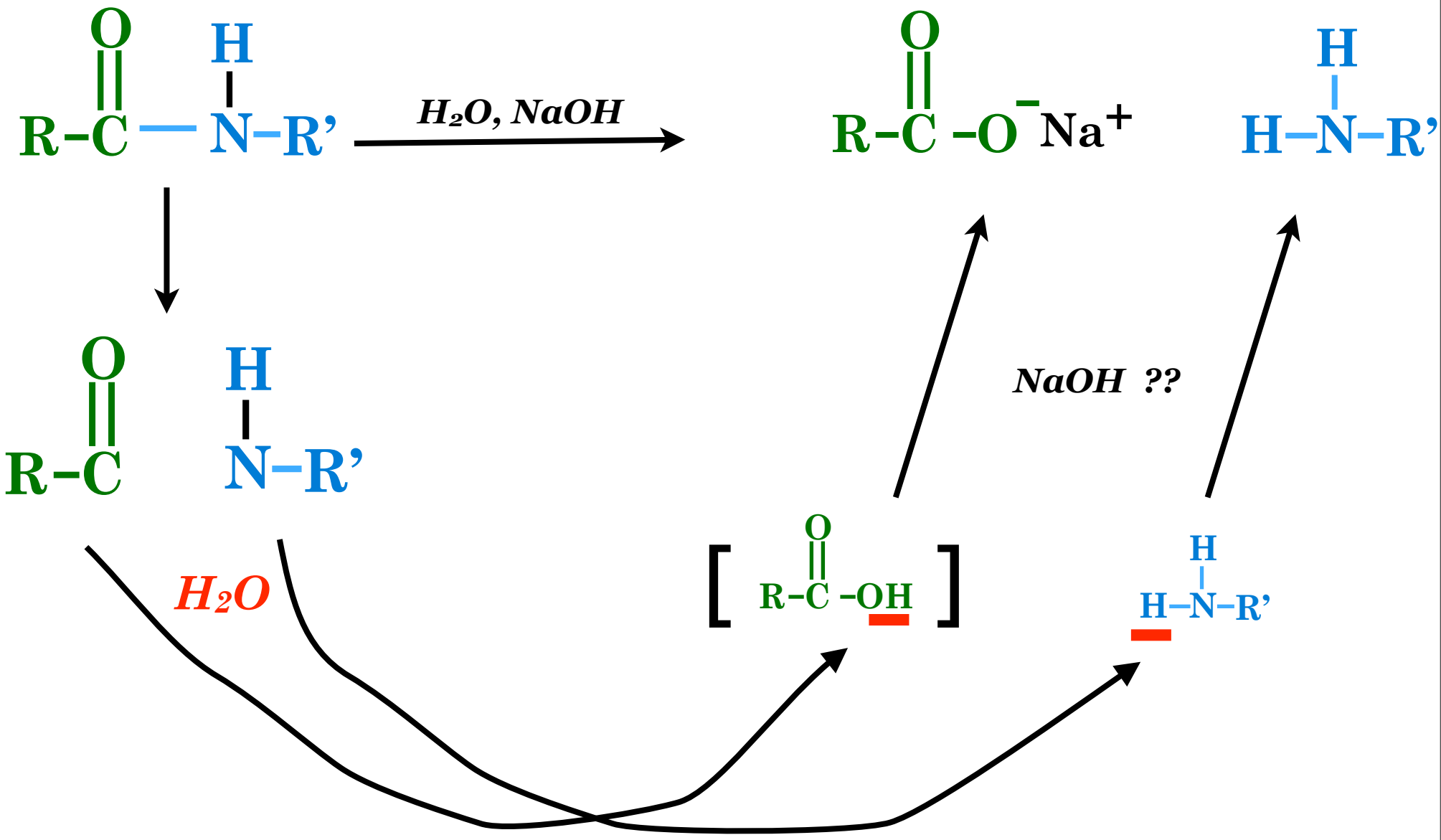
intermolecular attraction

Amides - Comparison to Other Families

Examples (MW 55–60)	bp (°C)
$CH_3-\overset{\overset{O}{\|}}{C}-NH_2$	222
$CH_3-\overset{\overset{O}{\|}}{C}-OH$	118
$CH_3CH_2CH_2OH$	97
$CH_3CH_2-C\equiv N$	97
$H-\overset{\overset{O}{\|}}{C}-OCH_3$	32
$CH_3CH_2CH_2CH_3$	0

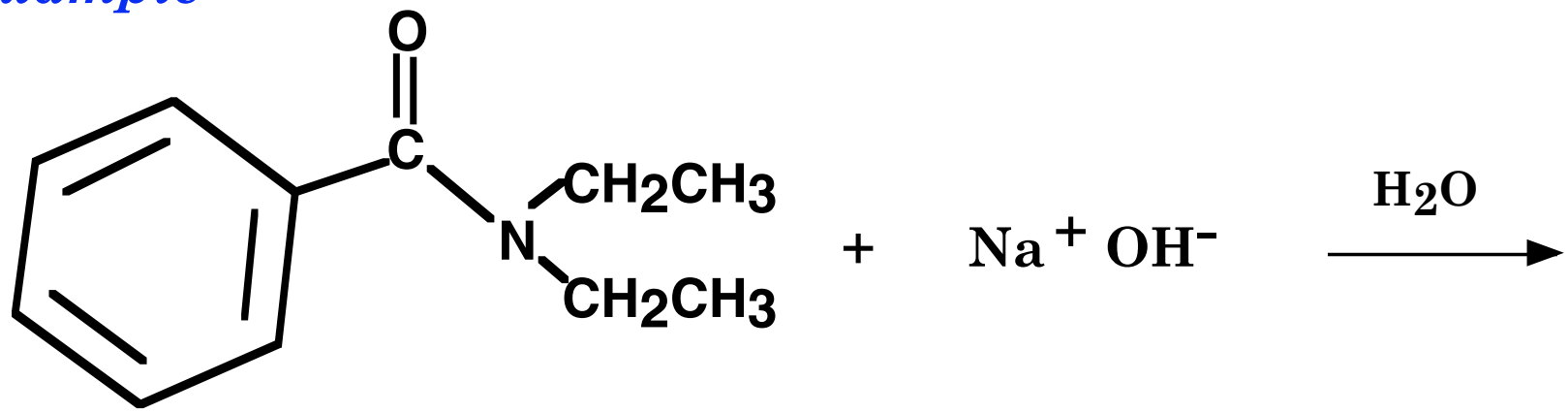


Amides - Basic Hydrolysis

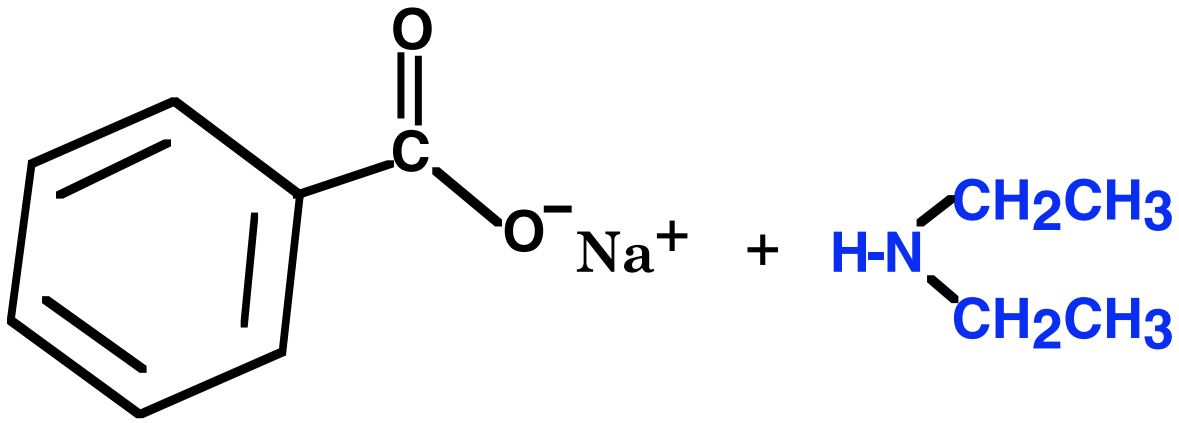


Amides - Basic Hydrolysis

Example



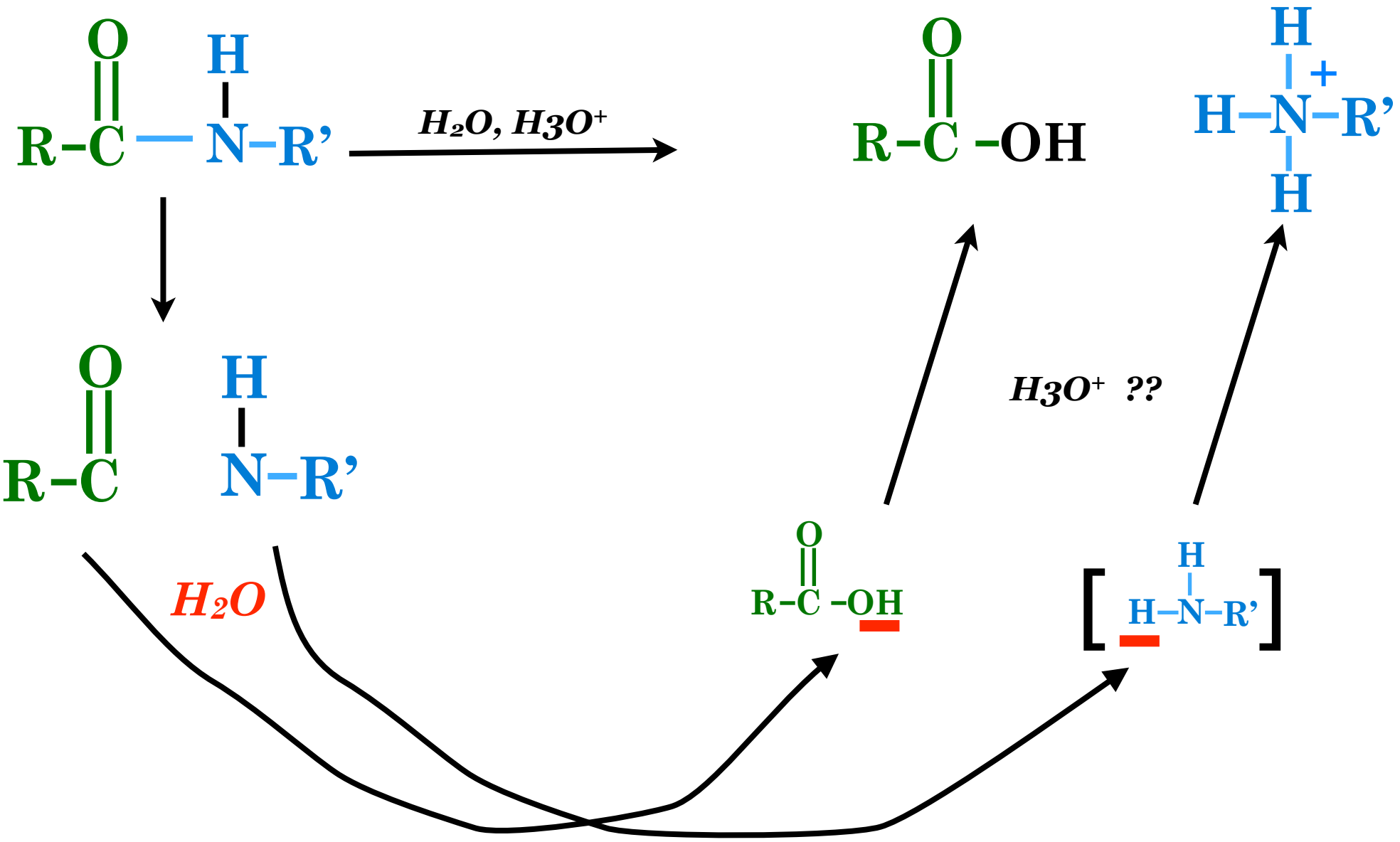
N,N-diethylbenzamide



sodium benzoate

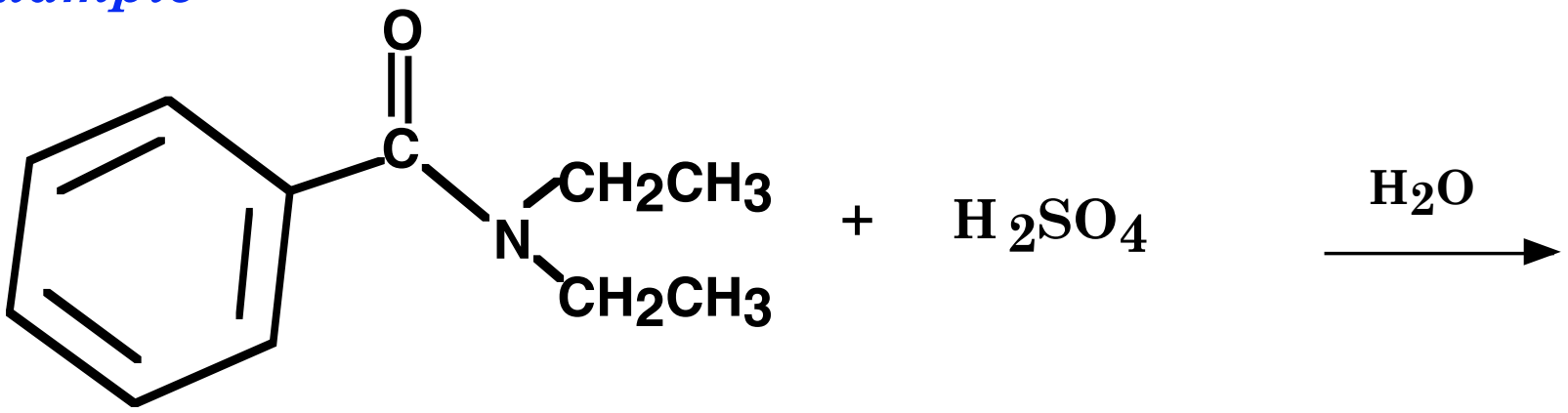
diethylamine

Amides - Acid Hydrolysis

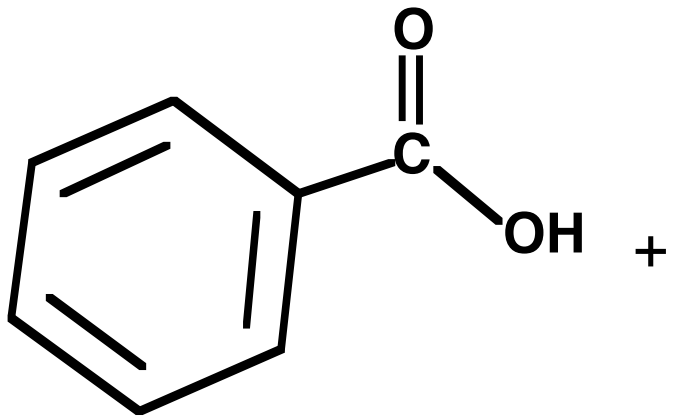


Amides - Acid Hydrolysis

Example

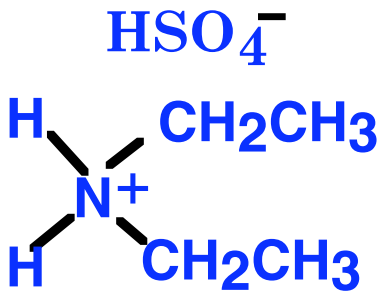


N,N-diethylbenzamide



benzoic acid

+



diethylammonium hydrogen sulfate