Carboxylic Acid Derivatives Nomenclature and Properties

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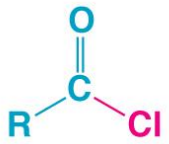
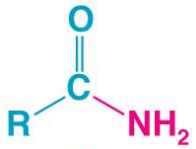
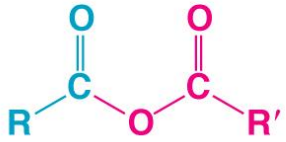
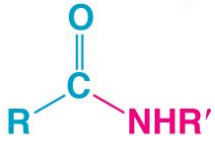
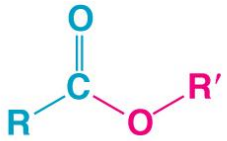
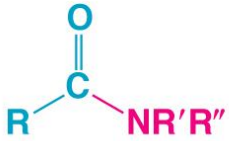
Derivatives

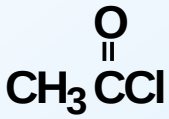
- The carboxyl group (-CO_2H) is the parent group of a family of compounds called *acyl compounds* or *carboxylic acid derivatives*
- The blue component below in the compounds are called “acyl”

Structure	Name	Structure	Name
	Acyl (or acid) chloride		Amide
	Acid anhydride		
	Ester		
	Nitrile		

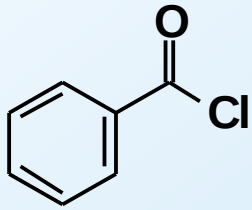
Acyl Chlorides

- Drop the *–ic acid* and use *–yl chloride*

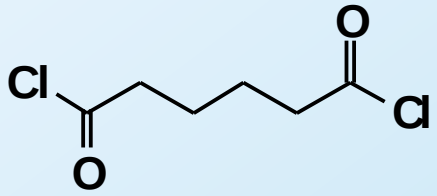
An acyl group



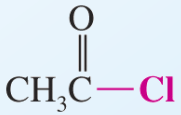
Ethanoyl chloride (Acetyl chloride)



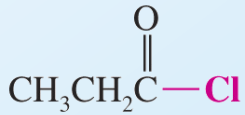
Benzoyl chloride



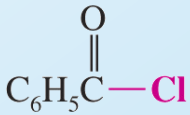
Hexanedioyl chloride (Adipoyl chloride)



Acetyl chloride (ethanoyl chloride)
mp −112°C; bp 51°C



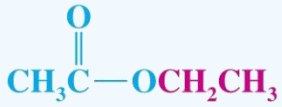
Propanoyl chloride
mp −94°C; bp 80°C



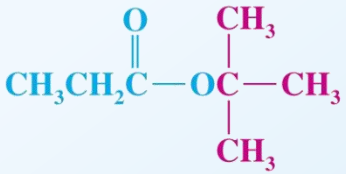
Benzoyl chloride
mp −1°C; bp 197°C

Esters

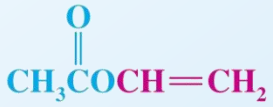
- Names of esters are based on the carboxylic acid and alcohol.
- Naming is like that of carboxylic acid salts, i.e. alcohol (cation) first and then the acid (anion) and end with –*ate*.



Ethyl acetate or
ethyl ethanoate

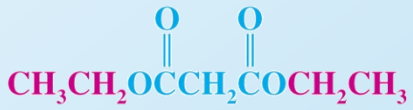


tert-Butyl propanoate



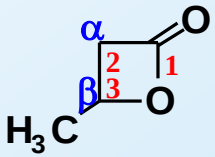
Vinyl acetate or
ethenyl ethanoate

Methyl *p*-chlorobenzoate

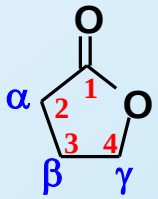


Diethyl malonate

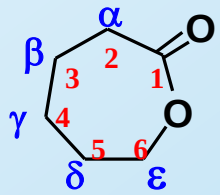
- Esters are internal groups, so can be found in cyclic compound. These esters are called lactones.



3-Butanolactone
(β-Butyrolactone)



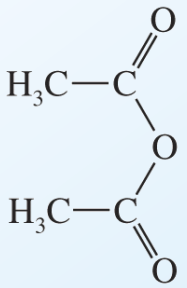
4-Butanolactone
(γ-Butyrolactone)



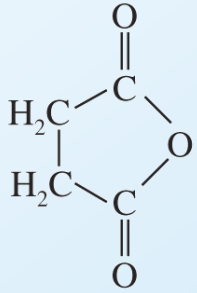
6-Hexanolactone
(ε-Caprolactone)

Anhydrides

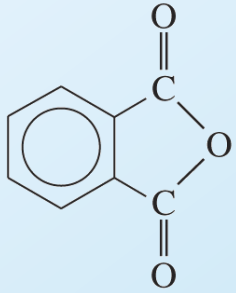
- Made from dehydrating two carboxylic acids.
- Named by dropping the acid and replacing it with anhydride.
- Anhydrides are internal groups so can be found in cyclic compounds (from diacids).



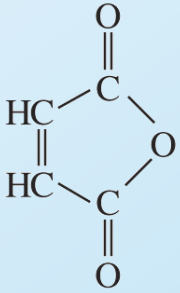
Acetic anhydride
(ethanoic anhydride)
mp −73°C



Succinic anhydride
mp 121°C



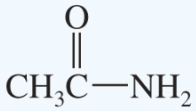
Phthalic anhydride
mp 131°C



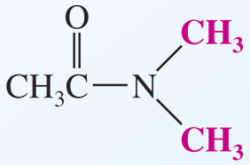
Maleic anhydride
mp 53°C

Amides

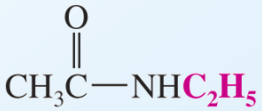
- Amides are made from acid + amine.
- Drop the –*oic acid* and replace with *amide*.



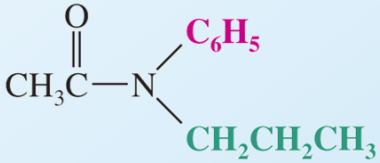
Acetamide
(ethanamide)
mp 82°C; bp 221°C



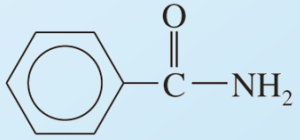
***N*,*N*-Dimethylacetamide**
mp −20°C; bp 166°C



***N*-Ethylacetamide**
bp 205°C

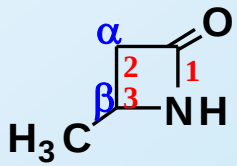


***N*-Phenyl-*N*-propylacetamide**
mp 49°C; bp 266°C at 712 torr

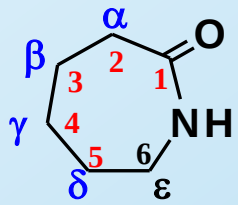


Benzamide
mp 130°C; bp 290°C

- Amides are internal groups, so can be found in a cyclic structure – these are called lactams.



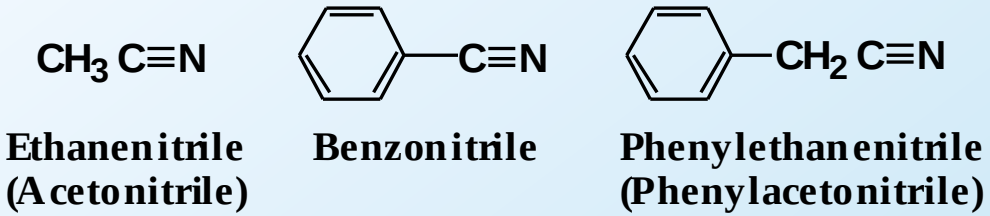
3-Butanolactam
(β-Butyrolactam)



6-Hexanolactam
(ε-Caprolactam)

Nitriles

- Most unusual of all carboxylic acid derivative – there is no oxygen!
- In inorganic chemistry CN^- is called cyanide; but in organic its called nitrile.
- To name nitriles, remove –*oic acid* and replace with *nitrile*.



Derivatives and Their Properties

O || RCCl Acyl chloride	O || RCOR Esters	O O || || RCOCR Anhydrides	RCN Nitriles	O || $RCNH_2$ Amides
No H bonding	No H bonding	No H bonding	No H bonding	H bonding
Low bpt and mpt	Low bpt and mpt	Low bpt and mpt	Low bpt and mpt	High bpt and mpt
	Salts of acid and alcohol			Salts of acid and amines
Soluble because of reaction	Slightly soluble in water	Soluble because of reaction		Soluble in water
Pungent odor	Fruity smells	Pungent odor		No odor

Key Concepts

- Recognize the structure of all derivatives
- Name all types of derivatives
- Predict physical properties of all derivatives