Carboxylic Acids
1 – Nomenclature, Properties and Applications

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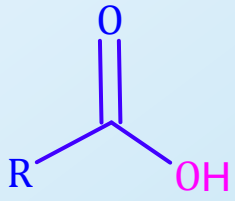
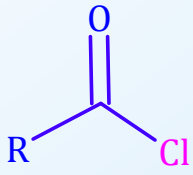
Introduction

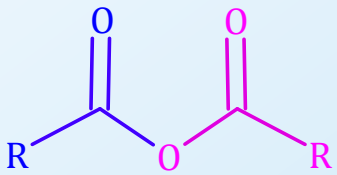
Carboxylic acids are RCOOH. There is a carbonyl along with an OH group.



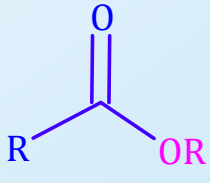
- Derivatives of acids are esters, amides and some more reactive are acyl chlorides, anhydrides and nitriles.
- C=O is common in all i.e., carbonyl group except nitriles.



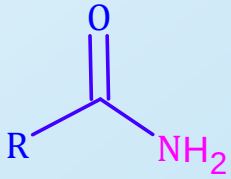
Acyl chloride



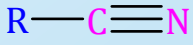
acid anhydride



carboxylic ester



amide



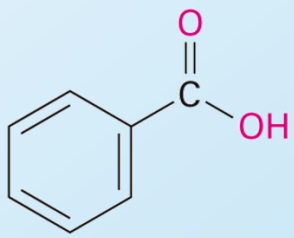
nitrile

Nomenclature

For names of acids, the corresponding alkane “e” is replaced with “–oic acid” as the suffix.

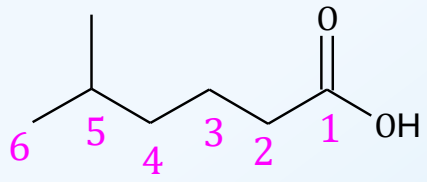
Like other carbonyl functional groups, a number of acids have common names. Given below are the IUPAC names followed by the common names of the first 4 carbon acids.

- HCOOH - Methanoic acid/*formic acid*
- CH_3COOH - Ethanoic acid/*acetic acid*
- CH_3CH_2COOH - Propanoic acid/*propionic acid*
- $CH_3CH_2CH_2COOH$ - Butanoic acid/*butyric acid*
- C_6H_5COOH – benzoic acid

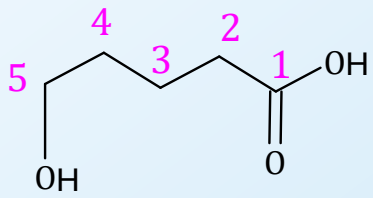


Nomenclature – contd…

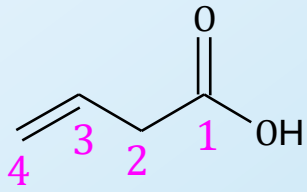
For substituents, start numbering from the C=O of acid. Carboxylic acid are the highest priority group in all functional groups.



5-methylhexanoic acid

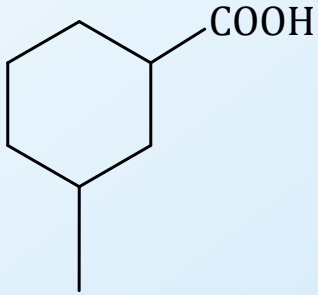


5-hydroxypentanoic acid



Buten-3-oic acid

For cyclic compounds use “carboxylic acid” as substituent.



3-methylcyclohenxanecarboxylic acid

Diacids

Diacids are when there are two acid groups in one molecule.

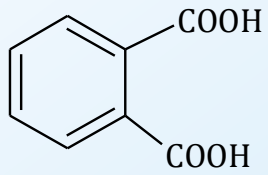
Most are usually known by their common names.

HOOC-COOH oxalic acid

$HOOCCH_2COOH$ malonic acid

$HOOC(CH_2)_2COOH$ succinic acid

Cis-HOOC-C=C-COOH maleic acid



phthalic acid

Physical Properties

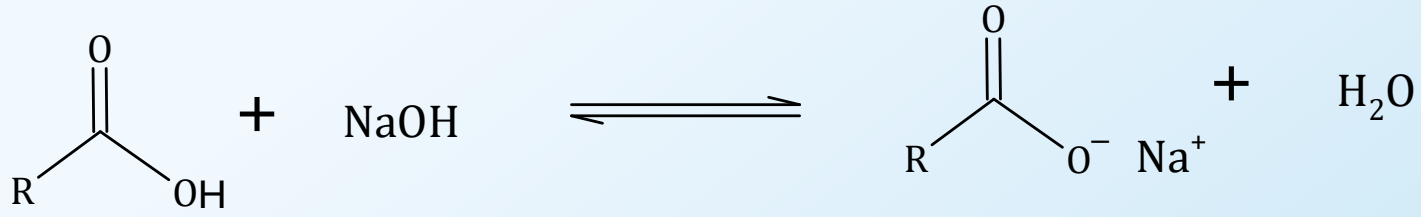
1) Boiling points – High because of hydrogen bonding and dipole forces. Even methanoic acid is a liquid of high boiling point. (see next slide). As molecular weight increases bpt increases. Diacids have higher bpt than mono acids.

2) Solubility in water – Smaller molecular weight acids are soluble in water due to hydrogen bonding. Solubility decreases as molecular weight increases.

3) Odor – Most acids are pungent in smell.

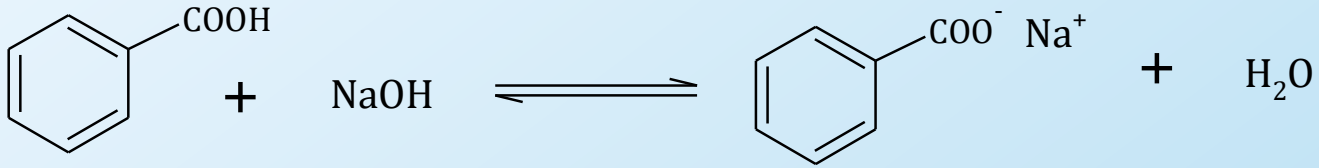
Acidity of Carboxylic Acids

The H of COOH is the most acidic protons and will readily react with bases to give carboxylate salts.



Salts of the acids are named as carboxylate salts, i.e. metal first and then anion (ending in – "ate").

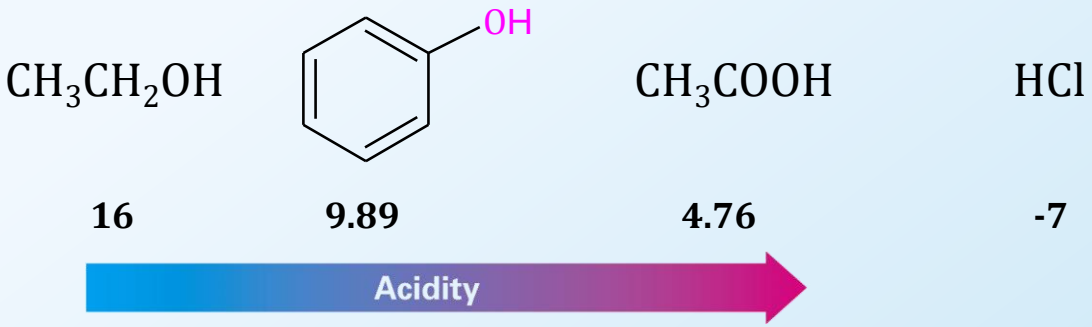
- $CH_3COO^-Na^+$: sodium ethanoate or sodium acetate.
- $CH_3CH_2COO^-K^+$: potassium propanoate.



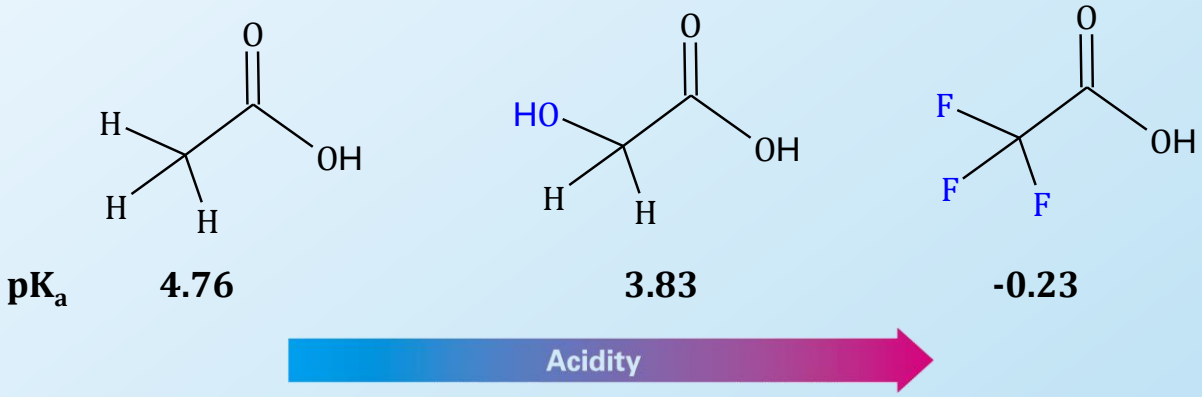
Benzoic acid sodium benzoate

Strength of Acids

Carboxylic acids are good acids due to polarity of the two oxygens.

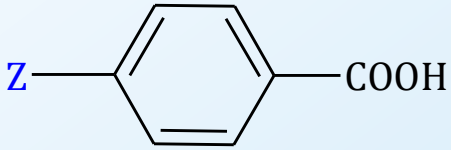


- The strength of the acid increases, due to inductive effect, when electronegative groups are on the acid.
- Fluoroacetic, chloroacetic, bromoacetic, and iodoacetic acids are stronger acids than acetic acid.



Acidity of Benzoic Acid Derivatives

An electron-withdrawing group (-NO_2) increases acidity by stabilizing the carboxylate anion, and an electron-donating (activating) group (OCH_3) decreases acidity by destabilizing the carboxylate anion.



Stronger acid

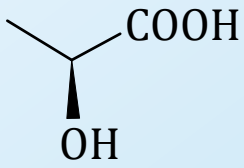
Weaker acid

Z	pKa
-NO_2	3.41
-CN	3.55
-CHO	3.75
-Br	3.96
-H	4.19
-CH_3	4.34
-OCH_3	4.46
-OH	4.48

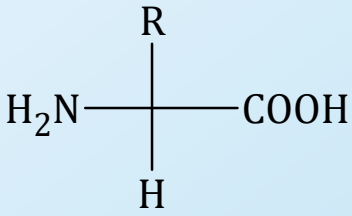
Applications

Carboxylic acids are found everywhere in our world.

1) Vinegar, acetic acid, is one of the most commonly found carboxylic acid. Fruit juices have a lot of organic acids.
2) Formic acid is found in the sting of ants.
3) Butyric acid is found in spoilt butter.
4) Hexanoic acid is the smell of dirty socks.
5) Lactic acid is found in spoilt milk.



6) Amino acids are naturally occurring molecules that have carboxylic acids and amine groups. There are 20 amino acids in our body with 20 different R groups.



Key Concepts

- Nomenclature
- Physical properties
- Acidity