▶ Video explanation (YouTube Short)

The Carboxyl Group: Structure and Naming

Carboxylic acids carry the **carboxyl group, –COOH**: a **carbonyl** group (C=O) and a **hydroxyl** group (–OH) on the same carbon, hence the name carb-oxyl.

1. Structure (NCERT 8.6.2)

The carboxyl carbon is sp² hybridised: its three bonds lie in one plane, about 120° apart.

Resonance. A lone pair on the –OH oxygen is delocalised towards the carbon (the C–O bond gains double-bond character, giving C=O⁺–H) while the π electrons of C=O move onto the carbonyl oxygen (O^-): R–C(=O)–OH ⟷ R–C(–O^-)=O⁺–H. This partly makes up the carbon's electron deficiency, so **the carboxyl carbon is less electrophilic than the carbonyl carbon of aldehydes and ketones**. Carboxylic acids therefore do not show the nucleophilic addition reactions of aldehydes and ketones.

2. Common names

Formula	Common name	Source (Latin)	IUPAC name
HCOOH	formic acid	formica, ant (ant stings)	methanoic acid
CH_3COOH	acetic acid	acetum, vinegar	ethanoic acid
CH_3CH_2COOH	propionic acid	–	propanoic acid
$CH_3CH_2CH_2COOH$	butyric acid	butyrum, butter (rancid butter)	butanoic acid
HOOC–COOH	oxalic acid	–	ethanedioic acid
C_6H_5COOH	benzoic acid	–	benzoic acid

3. IUPAC rules

- Replace the final **-e** of the alkane by **-oic acid**: methanoic, ethanoic, propanoic acid.
- The COOH carbon is **C-1**: $CH_3CH(CH_3)COOH$ is 2-methylpropanoic acid.
- Two COOH groups: **keep the -e** and add -dioic acid: HOOC–COOH is ethanedioic acid.

Solved example

Q. Name $CH_3CH(Cl)CH_2COOH$.
A. Number from the COOH carbon (C-1): the chain has 4 carbons, Cl on C-3: **3-chlorobutanoic acid**.

Key takeaways

- –COOH = C=O + –OH on one sp² carbon.
- Resonance makes the carboxyl carbon less electrophilic than in aldehydes and ketones.
- Common names come from natural sources (formica, acetum, butyrum).
- IUPAC: alkane − e + oic acid; C-1 is the COOH carbon; diacids keep the e.

Practice questions

1. (MCQ) The hybridisation of the carboxyl carbon is: (a) sp (b) sp^2 (c) sp^3 (d) dsp^2
2. (MCQ) The IUPAC name of HCOOH is: (a) formic acid (b) methanoic acid (c) methanol (d) ethanoic acid
3. (MCQ) Oxalic acid is: (a) ethanoic acid (b) ethanedioic acid (c) propanedioic acid (d) butanoic acid
4. (Very short) From which natural source does acetic acid get its name?
5. (Very short) Which carbon is numbered 1 in a carboxylic acid?
6. (Short) Why is the carboxyl carbon less electrophilic than the carbonyl carbon of an aldehyde?
7. (Short) Write the IUPAC name of $(CH_3)_2CHCOOH$.
8. (Application) Draw the two resonance structures of a carboxylic acid and show the curved arrows.

Answer key

1. (b) sp^2.
2. (b) methanoic acid.
3. (b) ethanedioic acid.
4. Vinegar (Latin acetum).
5. The carbon of the COOH group.
6. Resonance delocalises a lone pair of the –OH oxygen towards the carbon, so its electron deficiency (δ+) is partly made up.
7. 2-methylpropanoic acid.
8. R–C(=O)–OH ⟷ R–C(–O^-)=O^+–H: one arrow from an –OH lone pair to the C–O bond, one from the C=O π bond to the carbonyl O.

▶ Watch the video explanation