

Functional Groups

What are functional groups and how do they name and shape organic compounds?

●●● Intermediate

Organic Chemistry

Last reviewed 4 October 2026

Before you start: it helps to understand [Hydrocarbons and Naming Alkanes](#).

What is it?

A **functional group** is an atom or a small group of atoms that gives a family of organic compounds its typical reactions and properties. The rest of the molecule, a carbon chain written **R**, mostly just comes along for the ride.

Ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) and propan-1-ol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$) have different chains, but both contain the **-OH** group, so both are **alcohols** and react in the same ways.

Family	Group	Name ending (example)
Alkene	$\text{C}=\text{C}$	-ene (ethene)
Alcohol	$-\text{OH}$	-ol (ethanol)
Haloalkane	$-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$	fluoro-, chloro-, bromo-, iodo- (chloroethane)
Aldehyde	$-\text{CHO}$	-al (ethanal)
Ketone	$\text{C}=\text{O}$ inside the chain	-one (propanone)
Carboxylic acid	$-\text{COOH}$	-oic acid (ethanoic acid)
Ester	$-\text{COO}-$	-oate (ethyl ethanoate)
Amine	$-\text{NH}_2$	-amine (ethanamine)
Amide	$-\text{CONH}_2$	-amide (ethanamide)

KEY IDEA

Learn the functional group and you can predict the chemistry: every alcohol behaves like an alcohol, every acid like an acid. The **name** of a compound = the **stem** for the number of carbons (meth-, eth-, prop-...) + the **ending** for its functional group.

Why does it matter?

- **Prediction.** There are millions of organic compounds but only a few dozen functional groups, so the groups organize the whole subject.
- **Everyday life.** Esters give fruits their smells; ethanoic acid makes vinegar sour; propanone (acetone) is a common solvent.
- **Biology and medicine.** Amino acids carry an amine and a carboxylic acid group; proteins are held together by amide links; most medicines contain several functional groups.

How does it work?

1. Naming compounds with a functional group

1. Find the longest carbon chain that **contains** the functional group, and take its stem.
2. Number the chain so that the functional group gets the **lowest locant**.
3. Add the ending, with its locant before it: $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ is **propan-1-ol** and $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$ is **propan-2-ol**.

Aldehydes and carboxylic acids are always at the end of the chain (carbon 1), so they need no locant: **propanal**, **propanoic acid**. The carbon of the $-\text{CHO}$ or $-\text{COOH}$ group counts as part of the chain: ethanoic acid, CH_3COOH , has two carbons.

2. Naming esters

An ester forms from a carboxylic acid and an alcohol. Its name has two words: the **alkyl** group from the alcohol, then the acid name with **-oic acid** changed to **-oate**:

- ethanol + ethanoic acid → **ethyl ethanoate**, $\text{CH}_3\text{COOCH}_2\text{CH}_3$
- methanol + propanoic acid → **methyl propanoate**, $\text{CH}_3\text{CH}_2\text{COOCH}_3$

3. Functional groups and boiling points

Groups with an **O-H** or **N-H** bond (alcohols, carboxylic acids, amines) can form **hydrogen bonds** between molecules, so they boil much higher than hydrocarbons of similar mass:

Compound	Molar mass	Boiling point
propane, $\text{CH}_3\text{CH}_2\text{CH}_3$	44.09 g/mol	-42 °C
methoxymethane, CH_3OCH_3	46.07 g/mol	-24 °C
ethanol, $\text{CH}_3\text{CH}_2\text{OH}$	46.07 g/mol	78 °C

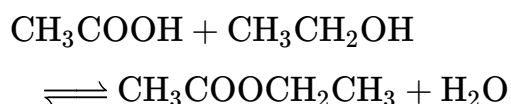
Methoxymethane (an ether) is polar but has no O-H bond; ethanol has one and boils about 100 °C higher. The same groups also make small molecules **soluble in water**, because they can hydrogen-bond to water molecules.

4. Functional group isomers

Ethanol and methoxymethane are both C_2H_6O : the same formula, but a different functional group, so they are different compounds with different properties. Likewise, C_3H_6O can be propanal (an aldehyde) or propanone (a ketone).

5. A key reaction: esterification

A carboxylic acid and an alcohol, warmed with a few drops of concentrated sulfuric acid as a catalyst, form an ester and water:



The reaction is reversible and reaches equilibrium, so the yield is usually well below 100 %.

THINK OF IT LIKE THIS

Think of a toolkit with interchangeable heads. The carbon chain is the handle: short or long, it feels much the same. The functional group is the head: a screwdriver head and a hammer head do completely different jobs, whatever handle they are fitted to.

MORE PRECISELY

Many functional groups are linked by **redox reactions**. Oxidizing a primary alcohol (–OH on an end carbon) gives an aldehyde and then a carboxylic acid: ethanol → ethanal → ethanoic acid, which is why wine left open turns to vinegar. A secondary alcohol (such as propan-2-ol) oxidizes to a ketone (propanone). When one molecule contains several groups, the IUPAC rules give priority to one of them for the ending (in order: acid, ester, aldehyde, ketone, alcohol, amine), and the others are named as prefixes.

Visualise it

Common functional groups

R and R' = carbon chains. The group (teal) sets the reactions.

Alcohol $\text{R}-\text{O}-\text{H}$ suffix -ol ethanol, $\text{CH}_3\text{CH}_2\text{OH}$	Aldehyde $\text{R}-\overset{\text{O}}{\underset{\text{ }}{\text{C}}}-\text{H}$ suffix -al ethanal, CH_3CHO
Ketone $\text{R}-\overset{\text{O}}{\underset{\text{ }}{\text{C}}}-\text{R}'$ suffix -one propanone, CH_3COCH_3	Carboxylic acid $\text{R}-\overset{\text{O}}{\underset{\text{ }}{\text{C}}}-\text{O}-\text{H}$ suffix -oic acid ethanoic acid, CH_3COOH
Ester $\text{R}-\overset{\text{O}}{\underset{\text{ }}{\text{C}}}-\text{O}-\text{R}'$ suffix -oate ethyl ethanoate, $\text{CH}_3\text{COOC}_2\text{H}_5$	Amine $\text{R}-\text{NH}_2$ suffix -amine ethanamine, $\text{CH}_3\text{CH}_2\text{NH}_2$
Haloalkane $\text{R}-\text{X}$ $\text{X} = \text{F}, \text{Cl}, \text{Br}, \text{I}$ prefix chloro- , bromo- chloroethane, $\text{CH}_3\text{CH}_2\text{Cl}$	Alkene >C=C< suffix -ene ethene, $\text{CH}_2=\text{CH}_2$

Name = chain length (meth-, eth-, prop-, but-...) + suffix.

Eight common functional groups. The chain R can change; the group decides the family name and the chemistry.

Worked example

WORKED EXAMPLE: Identifying and naming

Question: Name each compound and give its family: (a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (b) CH_3COCH_3 (c) $\text{CH}_3\text{CH}_2\text{COOH}$

- Step 1** (a) $-\text{OH}$ on carbon 1 of a 3-carbon chain: an alcohol, **propan-1-ol**.
- Step 2** (b) $\text{C}=\text{O}$ on the middle carbon of a 3-carbon chain: a ketone, **propanone**. (The $\text{C}=\text{O}$ cannot be at the end, or it would be an aldehyde, so no locant is needed.)
- Step 3** (c) $-\text{COOH}$ at the end of a 3-carbon chain (counting the COOH carbon): a carboxylic acid, **propanoic acid**.

 WORKED EXAMPLE: Naming an ester and writing its equation

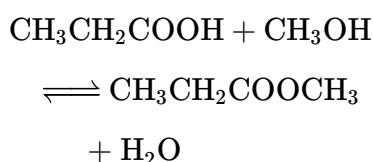
Question: Name the ester formed from methanol and propanoic acid, and write the equation.

Step 1 The alkyl group comes from the alcohol: methanol gives **methyl**.

Step 2 The acid part: propanoic acid gives **propanoate**.

Step 3 Name: **methyl propanoate**.

Step 4 Equation (checked: 4 C, 10 H, 3 O on each side):



 WORKED EXAMPLE: Percent yield of an esterification

Question: 6.00 g of ethanoic acid reacts with excess ethanol, and 5.28 g of ethyl ethanoate is collected. Find the percent yield. ($\text{CH}_3\text{COOH} = 60.05 \text{ g/mol}$; $\text{CH}_3\text{COOCH}_2\text{CH}_3 = 88.10 \text{ g/mol}$; 1 mol acid gives 1 mol ester)

Step 1 $n(\text{acid}) = \frac{6.00 \text{ g}}{60.05 \text{ g/mol}} = 0.09992 \text{ mol}$

Step 2 $n(\text{ester}) = 0.09992 \text{ mol}$ (1 : 1 ratio)

Step 3 Theoretical yield: $m = 0.09992 \text{ mol} \times 88.10 \text{ g/mol} = 8.803 \text{ g}$

Step 4 Percent yield = $\frac{5.28 \text{ g}}{8.803 \text{ g}} \times 100 \% = 60.0 \%$

Step 5 The yield is well below 100 % because esterification is reversible and reaches equilibrium.

Common mistake

 COMMON MISTAKE: Naming esters backwards

The alcohol part comes **first** and ends in -yl; the acid part comes **second** and ends in -oate. $\text{CH}_3\text{COOCH}_3$ is methyl ethanoate (from methanol + ethanoic acid), not ethyl methanoate.

 COMMON MISTAKE: Forgetting to count the functional-group carbon

In CH_3COOH the COOH carbon is part of the chain: two carbons, so it is **ethanoic** acid, not methanoic acid. The same applies to the CHO carbon of aldehydes.

 COMMON MISTAKE: Confusing -CHO and -OH

CH_3CHO (ethanal) is an aldehyde with a C=O double bond; it is not an alcohol, even though it contains O and H. An alcohol has the O bonded to H: -O-H .

 NOTATION NOTE

- Common names you will meet: acetic acid = ethanoic acid; acetone = propanone; acetaldehyde = ethanal; formaldehyde = methanal; ethyl acetate = ethyl ethanoate; isopropyl alcohol = propan-2-ol.
- In condensed formulas, -CHO means an aldehyde group, -COOH a carboxylic acid group and -COO- an ester link.
- R and R' stand for carbon chains, which may be the same or different.

Remember this

 REMEMBER THIS

- **Functional group** = the reactive part of the molecule; it decides the family, the name ending and the chemistry.
- **Endings:** -ene, -ol, -al, -one, -oic acid, -oate, -amine, -amide; halogens are prefixes (chloro-).
- **Number the chain** so the functional group gets the lowest locant; -al and -oic acid are always carbon 1.
- **O-H and N-H groups hydrogen-bond:** higher boiling points and better water solubility.
- **Acid + alcohol** $\rightleftharpoons$ ester + water (acid catalyst); ester name = alkyl (from alcohol) + -oate (from acid).

References

1. Brown, T. L.; LeMay, H. E., Jr.; Bursten, B. E.; Murphy, C. J.; Woodward, P. M.; Stoltzfus, M. W. Chemistry: The Central Science, 15th ed.; Pearson, 2022.

Practise this topic with flashcards and a quiz at chemistryclarity.com/chemistry/functional-groups/