

Organic Chemistry Nomenclature

Traditionally, organic compounds have been given *trivial names* that often have some link with their historical sources. Knowing the name of a compound didn't necessarily mean that you could work out the structure. There was a logic involved and predictions could be made once you knew a few simple clues. Some names include *acetic acid*, *aniline*, *acetone*, *oil of wintergreen*.

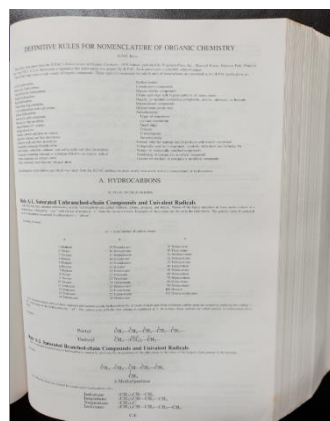
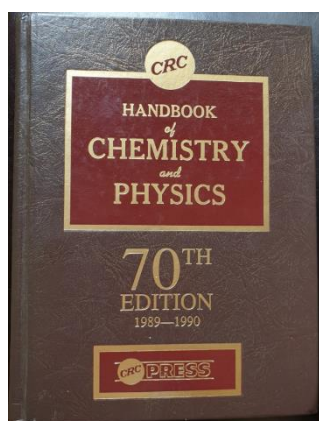
For example, *formic acid*, is a naturally occurring acid in nature. It is produced by certain ants (genus. *formica*) and nettles. They have evolved to use this as a natural defence. The name formic acid derives from the Latin for the kind of ants that produce it.

Methanoic acid is the systematic name for *formic acid*. The molecular formula is HCOOH. It is the simplest carboxylic acid with 1 carbon. Once you know this, then you can predict that formaldehyde (from the family called aldehydes) has only a single carbon. So, those old trivial names still have use. In the world of chemistry, beyond school, these names are still very popular, and it would be good to get to know some.

Anyway, you need to be able to use a much more systematic nomenclature for naming organic compounds at A level.

IUPAC Rules for Naming

Here are some very simplified rules to help you name compounds. They are a simplified version of the full IUPAC (International Union of Pure and Applied Chemistry) rules that run to many volumes. I have a summary of them in this hefty book '*Handbook of Chemistry and Physics*'. In this book the rules were cut down to just 27 pages!



Remember, with a systematic name, the name tells you **unambiguously** what the compound is. You do not need to have prior knowledge like you do with trivial names. You can only know what *oil of wintergreen* is if you have come across it before. Incidentally, this molecule is the main flavouring in the soft drink, Root Beer. People seem to love it or hate it. Personally, I love it.

Oil of Wintergreen is correctly named *methyl 2-hydroxybenzoate*

Here are some simple **rules** to follow:

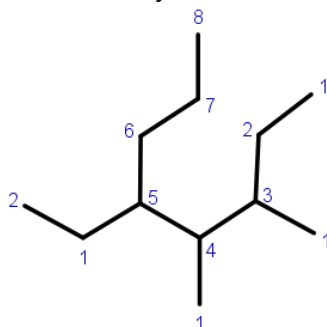
1. Establish the **longest chain of carbons** in the structure. Once you've done this, you need to use that as the root of the name.

You are familiar with these roots as they occur in the aliphatic homologous series of alkanes.

no. of C	name of alkane	no. of C	name of alkane
1	meth ane	6	hex ane
2	eth ane	7	hept ane
3	prop ane	8	oct ane
4	but ane	9	non ane
5	pent ane	10	dec ane

Be careful, the longest chain may not be instantly obvious. This is especially true in larger molecules.

e.g.



the longest continuous chain of carbons in this molecule is 8!

2. If the chain has **side groups** bonded to it, you need to decide what is the name of the group and to which carbon it is bonded.

If the side group is simply a carbon chain (and **alkyl** group) you simply use the terms:

methyl, ethyl, propyl, butyl, pentyl

3. If the chain has a **functional group**, you need to work out what it is called and how it should be written in a systematic name.

Here is where it gets a little trickier. That's because functional groups can have 2 possible ways of naming them when they form part of a name.

If the name has the functional group at the **end** of the name, we call it a **suffix**.

If the name has the functional group at the **start** or within the name, we call it a **prefix**.


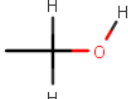
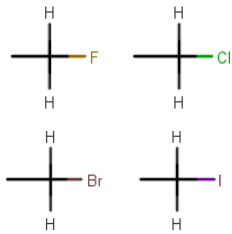
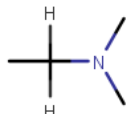
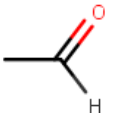
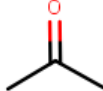
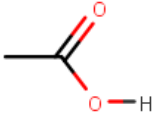
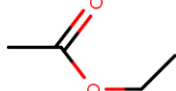
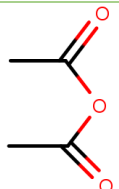
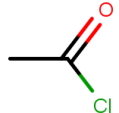
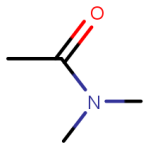


A simple example is a molecule containing an -OH group.

This can take **hydroxy** if OH is used a prefix or **ol** if it is used as a suffix.

CH₃CH₂CH₂OH could be named either 1-**hydroxy**propane or propan-1-**ol**

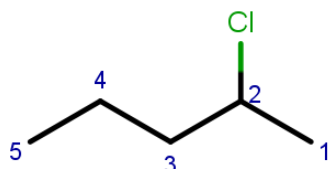
A table of the prefixes and suffixes in organic names is given below.

This table is also available as a pdf in [TOOLS](#) > [Data Tables](#)

Functional Group	exists in	prefix-	-suffix	e.g. with prefix and suffix
	alkenes	-	-ene	propene
	alcohols	hydroxy-	-ol	hydroxypropane propanol
	haloalkanes	fluoro- chloro- bromo- iodo-	fluoride chloride bromide iodide	chloromethane methylchloride
	amines	amino-	-amine	aminoethane ethylamine
	aldehydes	formyl- (unlikely at A level!)	-al	butanal
	ketones	OXO- (unlikely at A level!)	-one	propanone
	carboxylic acids	carboxy- (unlikely at A level!)	-oic acid	ethanoic acid
	esters	-	-oate	ethyl propanoate
	acid anhydrides	-	-oic anhydride	propanoic anhydride
	acid/acyl chlorides	-	-oyl chloride	ethanoyl chloride
	amides	amido (unlikely at A level!)	-amide	ethanamide
	nitriles	cyano- (care with carbon count!)	-nitrile	cyanoethane propanenitrile
	arenes	phenyl-	-benzene	Phenylbutane butylbenzene

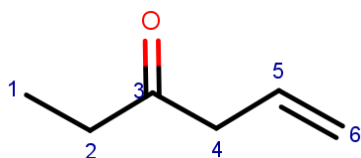
4. The next decision that you need to make involves **numbering the carbon chain**. Carbons in the chain need to be given numbers from 1 upwards. Carbon 1 needs to be at one end of the chain. To decide which end of the chain is numbered 1, you need to decide where the side groups/functional groups are. You need to number the chain so that the side-groups/functional groups are on carbons in the chain with the lowest numbers. Here, the right-hand carbon is carbon number 1

e.g.



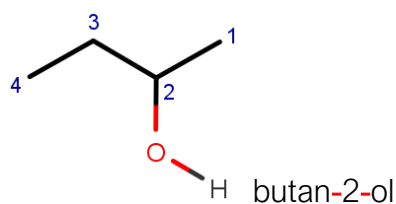
(Actually, there is a hierarchy of functional groups where some take precedence over others. For example, ketones should be numbered before a double bond. The C=O should be numbered before the C=C so the C=O will be on the lowest number carbon, regardless of the C=C position. **Don't worry too much about this at A level!**)

e.g.



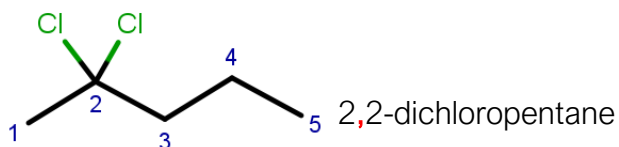
5. The order of the functional groups in the name should follow alphabetical order, not the order of the carbon numbers.
6. When **numbers** are written in the name, they should be separated from letters by a **dash**

e.g.



7. When one number immediately follows another in the name, they should be separated by a **comma**.

e.g.



So **dashes** between numbers and letters. **Commas** between consecutive numbers.

Some worked examples to demonstrate how naming works:

Compound	Name	breakdown	reason
	2-methylpentane	2-	side-chain on lowest numbered carbon, so 2
		methyl	side chain is methyl
		pent	longest chain is 5 carbons
		ane	carbon chain is saturated
	hex-2-ene	hex	longest chain is 6 carbons
		-2-	double bond starts on carbon number 2
		ene	carbon chain is unsaturated
	pentan-3-one	pent	longest chain is 5 carbons
		an	carbon chain is saturated
		-3-	Functional group is on carbon number 3
		one	functional group is a ketone
	2-methylbutanal	2-	methyl group is on carbon number 2
		methyl	side chain is methyl
		but	longest chain is 4 carbons
		an	carbon chain is saturated
	2-aminobutane	2-	functional group is on carbon number 2
		amino	functional group is an amine
		but	longest chain is 4 carbons
		ane	carbon chain is saturated
	3,3-dihydroxycyclohexan-1-one	3,3	functional groups on carbon number 3
		dihydroxy	2 hydroxy functional groups present
		cyclo	compound is alicyclic
		hex	carbon ring has 6 carbons
		an	carbon ring is saturated
		-1-	ketone function is on carbon number 1
		one	the compound is a ketone

This can be applied to molecules of any size and with many functional groups.

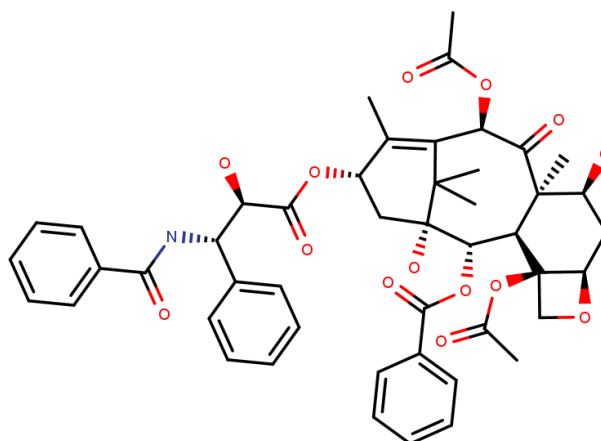
This is a great example.

Its trivial name is **Taxol**.

This is my favourite molecule ever!

It's been shown to have powerful antineoplastic action (anticancer).

It naturally occurs in the pacific yew tree (*taxus brevifolia*)



Naming this is a nightmare. There are several unambiguous possibilities.

Here is one suggestion from Wikipedia:

(1R,2S,3R,4R,7R,9S,10R,12R,15S)-4,12-bis(acetyloxy)-1,9-dihydroxy-15-[[[(2R,3S)-2-hydroxy-3-phenyl-3-(phenylformamido)propanoyl]oxy]-10,14,17,17-tetramethyl-11-oxo-6-oxatetracyclo[11.3.1.0~3,10~.0~4,7~]heptadec-13-en-2-yl benzoate

Have a go at the following of exercises.

1. For these structural formulae, give a systematic name:

- a) $\text{CH}_3\text{CH}_2\text{CH}_3$
- b) $\text{CH}_3\text{CHCHCH}_2\text{CH}(\text{CH}_3)_2$
- c) $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)_2$
- d) $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
- e) $\text{CH}_3\text{CHClCH}(\text{OH})\text{CHBrCH}_2\text{CH}_3$
- f) $\text{ClCH}_2\text{COCH}_2\text{CH}_3$
- g) $\text{CH}_3\text{C}(\text{CH}_3)_2\text{COCH}_2\text{CH}_3$
- h) $\text{CH}_3\text{CH}(\text{CHO})\text{CH}(\text{CH}_3)\text{CH}_2\text{Cl}$
- i) $\text{CH}_3\text{CH}_2\text{CHClCOOH}$
- j) $\text{CH}_3\text{CH}(\text{COOH})\text{CH}_3$
- k) $(\text{CH}_3)(\text{C}_2\text{H}_5)\text{NH}$
- l) $\text{Cl}_2\text{FCH}_2\text{Cl}$

2. Write structural formulae from the following systematic names

- a) 2,3-dimethylbutane

- b) propan-2-ol

- c) 2,2-dimethylbutanal

- d) 1-chloro-2-iodo-4-methylpentan-3-one

- e) aminoethane

- f) aminoethanoic acid

- g) 6-iodohex-2-ene

- h) 2,3-dimethylpent-2-ene

- i) 3-bromo-2-chloro-4-iodopentane

- j) ethane-1,2-diol

- k) 1,2,2,2-tetrachloroethane

Why not have a go at the self-marking quiz on organic nomenclature on *CramNow*. You'll find it in M4. It's called *Y1 Organic Nomenclature*.

ANSWERS:

1.

- a. Propane
- b. 2-methylhex-4-ene
- c. 2-methylbutane
- d. Butan-2-ol
- e. 4-bromo-2-chlorohexan-3-ol
- f. 1-chlorobutan-2-one
- g. 2,2-dimethylpentan-3-one
- h. 4-chloro-2,3-dimethylbutanal
- i. 2-chlorobutanoic acid
- j. 2-methylpropanoic acid
- k. Ethylmethanamine
- l. 1,1,2-trichloro-1-fluoroethane

2.

- a. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{CH}_3$
- b. $\text{CH}_3\text{CHOHCH}_3$
- c. $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{CHO}$
- d. $\text{CH}_2\text{ClCH}(\text{COCH}(\text{CH}_3)_2)$
- e. $\text{CH}_3\text{CH}_2\text{NH}_2$
- f. $\text{H}_2\text{NCH}_2\text{COOH}$
- g. $\text{CH}_3\text{CHCHCH}_2\text{CH}_2\text{CH}_2\text{I}$
- h. $(\text{CH}_3)_2\text{CC}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- i. $\text{CH}_3\text{CHClCHBrCHICH}_3$
- j. $\text{CH}_2\text{OHCH}_2\text{OH}$
- k. $\text{CCl}_3\text{CH}_2\text{Cl}$