Naming organic Chemistry A2

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Chemrevise.org

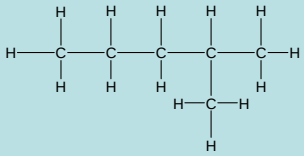
DIFFERENT FORMULAE

- **General** represents *any member* of a homologous series
  C_nH_{2n+2} for an alkane;
  C_nH_{2n} for an alkene
- **Molecular** shows the *exact number* of atoms of each type
  C_4H_{10} for butane
- **Empirical** shows the *simplest whole number ratio* of atoms
  C_2H_5 for butane

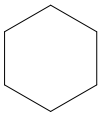
•**Condensed Structural** the minimal detail, using *conventional groups*, for an unambiguous structure.
$CH_3CH_2CH_2CH_3$ for butane

Brackets indicate branching.
$CH_3CH(CH_3)CH_3$ for methyl propane

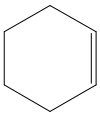
Displayed shows every bond and every atom



Skeletal used to show a simplified organic molecule. No carbon or hydrogen atoms are drawn



cyclohexane



cyclohexene

butane

- A carbon atom is represented by a join of lines at an angle
- Functional groups are drawn
- The number of hydrogen atoms on each carbon atom will be how many extra bonds needed to make up four bonds

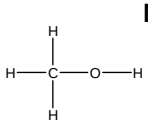
HOMOLOGOUS SERIES

These are a series of compounds of similar structure in which each member differs from the next by a common repeating unit, CH_2. Series members are called homologues.

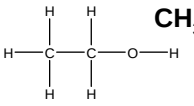
- All share the **same general formula**.
- Formula of a homologue differs from its neighbour by CH_2. (e.g. CH_4, C_2H_6, ... etc)
- Contain the **same functional group**
- Have **similar chemical properties**.
- Show a gradual change in physical properties as molar mass increases.
- Can usually be prepared by similar methods.

E.g. the first three homologues of the alcohol series, each containing the –OH functional group

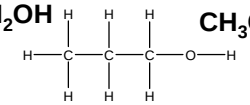
Methanol
CH_3OH



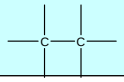
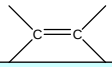
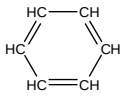
Ethanol
CH_3CH_2OH

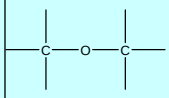
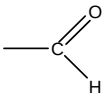
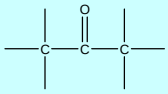


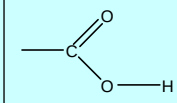
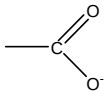
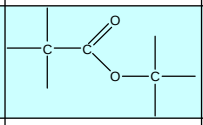
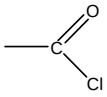
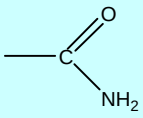
Propan-1-ol
$CH_3CH_2CH_2OH$



Different types of functional groups

Group of compounds	Functional group	Naming compound (prefix-) (*–suffix*)	Example	
			Name	Structure
Alkane		*-ane*	But*ane*	$CH_3CH_2CH_2CH_3$
Alkene		*-ene*	Prop*ene*	CH_2CHCH_3
Alkyne		*-yne*	Eth*yne*	CHCH
Arene			Benzene	C_6H_6 
Haloalkane	X where X = F, Cl, Br, I	*Halo-* [*Fluro-*, *Chloro-*, *Bromo-*, *Iodo-*]	1-*bromo*butane	$CH_3CH_2CH_2CH_2Br$
Amine		*-amine*	Methyl*amine*	CH_3NH_2

Nitrile		*-nitrile*	Pentane*nitrile*	C_4H_9CN
Alcohol		*-ol*	Propan-1-*ol*	$CH_3CH_2CH_2OH$
Ether		*-oxy –ane*	Eth*oxy*eth*ane*	CH_3OCH_3
Aldehyde		*-al*	Ethan*al*	CH_3CHO
Ketone		*-one*	Butan*one*	$CH_3CH_2COCH_3$

Carboxylic acid		*-oic acid*	Ethan*oic acid*	CH_3COOH
Carboxylate ion		*-oate*	Sodium ethan*oate*	$CH_3COO^-\ Na^+$
Ester		*-yl –oate*	Eth*yl ethanoate*	$CH_3COOCH_2CH_3$
Acyl chloride		*-oyl chloride*	Ethan*oyl chloride*	CH_3COCl
Amide		*-amide*	Ethan*amide*	CH_3CONH_2

NAMING ORGANIC COMPOUNDS

The systematic name of an organic compound tells us:

i. The **number of carbon atoms** in the **longest chain** or **ring**.
This is the prefix of the name

ii. The nature and position of any **functional group(s).**
This is the suffix of the name

iii. The position of any **side chain branches** and **number of carbon atoms in the branch**.

2-methylbutan-1-ol

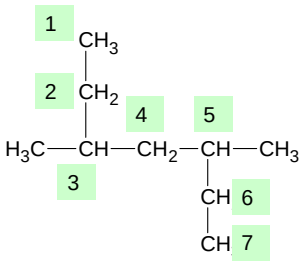
Branch containing one carbon atom, attached to the second atom of the longest chain

Four carbon atoms in longest carbon chain

Contains alcohol functional group, attached to first carbon atom in the longest chain

Naming organic compounds: The different components

Count the number of carbon atoms in the longest chain



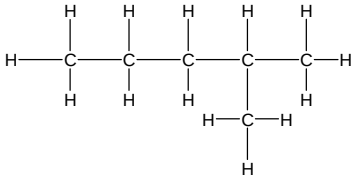
hept

code	no of carbons
meth	1
eth	2
prop	3
but	4
pent	5
hex	6
hept	7
oct	8
non	9
dec	10

Naming Branched Hydrocarbons

1. Count the longest carbon chain and name appropriately

Eg pentane



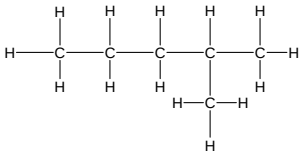
2. Locate any side chains and count how many carbons they contain Eg $-CH_3$ methyl or $-C_2H_5$ ethyl

Number of carbon atoms in branch	Name of alkyl group	Structural Formula
1	Methyl-	CH_3-
2	Ethyl-	CH_3CH_2-
3	Propyl-	$CH_3CH_3CH_2$-
4	Butyl-	$CH_3CH_3CH_3CH_2$-
5	Pentyl-	$CH_3CH_3CH_3CH_3CH_2$-

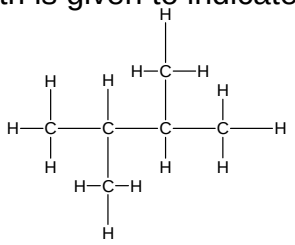
Naming branched compounds cont.

3. Give the side chain the number the carbon is on. Eg 2-methyl. (Count from either end to give the lowest number.)

In the example above:
2-methyl pentane

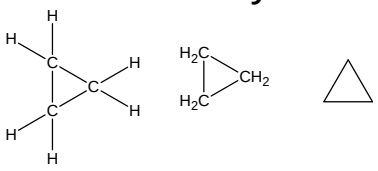


4. If there is more than one methyl group, then each one must have a number locating its carbon atom and a pre-fix of di or tri is given to indicate the total number of methyl groups

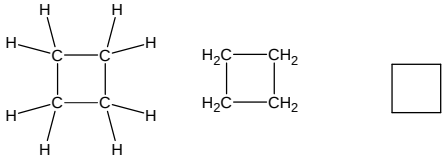


2,2- dimethyl butane

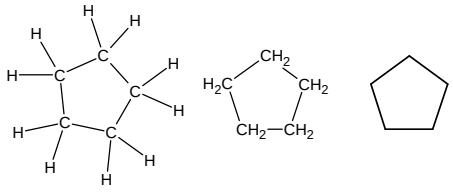
Hydrocarbon Rings



Cyclopropane. Molecular formula C_3H_6



Cyclobutane. Molecular formula C_4H_8



Cyclopentane. Molecular formula C_5H_{10}

Cycloalkanes have the same general formula as alkenes

e.g. C_nH_{2n}

For **rings** of carbon atoms, cyclo- is put in front of the name

General naming rules

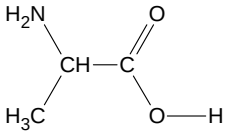
- The position of the functional group is given by a number, counting from the end that gives the functional group the lowest number (for aldehydes, carboxylic acids & nitriles, the functional group is position 1). *e.g. butanal.*
- Where there are two or more of the same groups, *di-*, *tri-* or *tetra* are used.
- If there is more than one functional group, numbers are separated by commas and the groups are listed in alphabetical order (ignoring *di*, *tri*, etc.). *e.g. 3-bromo-1-chlorobutane, 2,2-dibromo-1-chlorobutane*.
- Numbers are separated by commas and word and numbers by dashes, *e.g. 1-chloro-2,3-dimethylbutane*.
- If a number is not necessary (i.e. the group could only be in one place) then no number should be given. e.g. *propene, methylpropane*

General naming rules

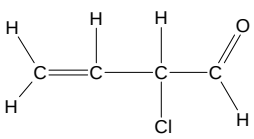
- Where there are two functional groups, both with suffixes, the preference for the one to have the suffix is

  carboxylic acid > aldehyde > ketone > alcohol. *e.g. 2-hydroxypropanoic acid, 2-aminopropanoic acid. 2-oxo butanoic acid*

2-aminopropanoic acid



•The suffix for alkenes can go in front of other suffixes, *e.g. 2-chlorobut-3-enal.*



To ‘e’ or not to ‘e’

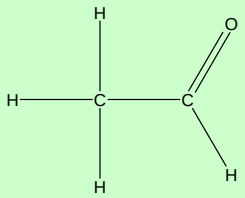
•When using a suffix, add in the following way :

If the suffix starts with a vowel- remove the –e from the stem alkane name
e.g. Propan-1-ol, butan-1-amine, ethanoic acid, ethanoylchloride, butanamide

If the suffix starts with a consonant or there are two or more of a functional group meaning di, or tri needs to be used then **do not remove the the –e** from the stem alkane name
e.g. Propan**e**nitrile, ethan**e**-1,2-diol, propan**e**dioic acid, propan**e**-1,2,3-triol, pentane-2,4-dione

Naming Carbonyls

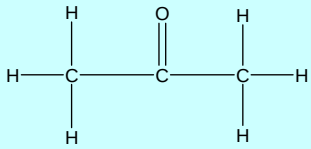
Carbonyls are compounds with a C=O bond, they can be either aldehydes or ketones.



ethanal CH_3CHO

If the C=O is on the end of the chain with an H attached it is an aldehyde.

The name will end in –al



CH_3COCH_3 propanone

If the C=O is in the middle of the chain it is a ketone
The name will end in -one

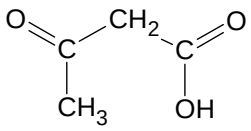
Naming Carbonyls

Aldehydes never need a number in the name because by definition the functional group is on the end of the chain

Ketones need numbering if there is more than one possibility about where the C=O bond can be.

e.g. propanone and butanone do not need numbers but with 5C's there could be pentan-2-one and pentan-3-one

The prefix oxo should be used for compounds that contain a a ketone group in addition to a carboxylic acid

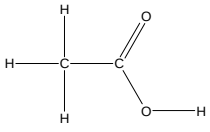


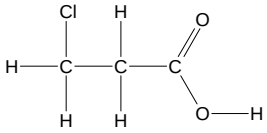
3-oxobutanoic acid

Naming Carboxylic acid

These have the ending **-oic acid**, but no number is necessary for the acid group as it must always be at the end of the chain. The numbering always starts from the carboxylic acid end.

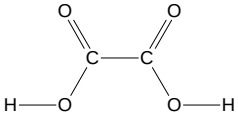
ethanoic acid





3-chloropropanoic acid

If there are carboxylic acid groups on both ends of the chain then it is called a - dioic acid



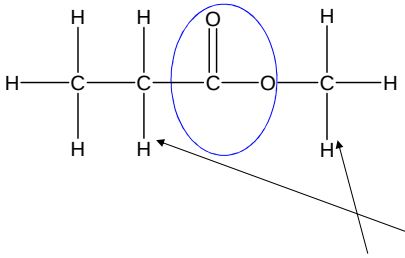
Ethan**e**dioic acid

$(CO_2H)_2$

Naming Esters

Esters have carbon chains attached to either side of the functional group

An Ester



Esters have two parts to their names, eg methyl propanoate.

The bit ending in –yl is next to the single bonded oxygen.

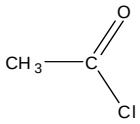
The bit ending in –anoate is the chain including the C=O bond

key

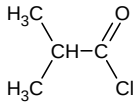
Naming Acyl Chlorides

Acyl chlorides are carboxylic acid derivatives.

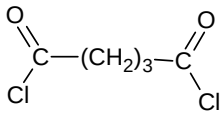
To name take the carboxylic acid name, remove the oic acid bit of the name and replace by **–oyl chloride**



ethanoyl chloride



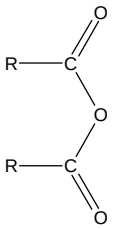
2-methylpropanoyl chloride



Pentan**e**dioyl dichloride

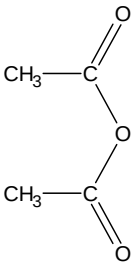
Naming Acid Anhydrides

Generalised structure of acid anhydride

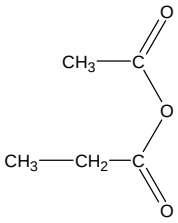


If the R group is the same the name takes the length of R group +1

Ethanoic anhydride

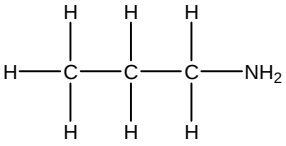


If the groups are different then each one is named e.g. ethanoic propanoic anhydride.



Naming amines

Amines
These end in **–amine**.
There is, however, rather confusingly two ways of using this suffix.
The exam board tend to use the common version where the name stem ends in **-yl** prop**yl**amine.
The IUPAC version of the same chemical is propan-1-amine. (This is used in the same way as naming alcohols)

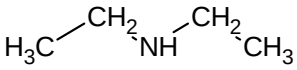


prop**yl**amine
Or propan-1-amine

If the amine is secondary and has two alkyl groups attached to the nitrogen, then each chain is named and the smaller alkyl group is preceded by an –N which plays the same role as a number in positioning a side alkyl chain

$CH_3CH_2CH_2NHCH_3$
N-methylpropylamine (common name)
N-methylpropan-1-amine (IUPAC name)

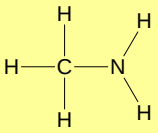
In the common naming version if the chain lengths are the same an –N is not used



Diethylamine (common name- does not use N if chains are same length)
N-ethylethanamine (IUPAC name does still use N)

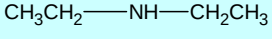
Naming Amines

primary amine (one C attached to N)



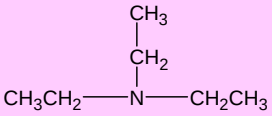
name: methylamine

Secondary amine (two C's attached to N)



name : diethylamine
N-ethylethanamine

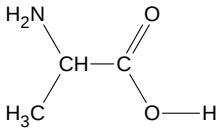
tertiary amine (three C's attached to N)



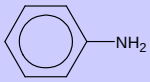
name: triethylamine

Naming Amines

If there is another functional group as well as the amine group then the prefix amino is used. e.g. 2-aminopropanoic acid.



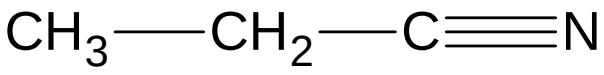
It is also possible to have aromatic amines



phenylamine

Naming Nitriles

These end in **–ile**, but the C of the CN group counts as one of the chain.



propanenitrile

Note the stem of the name is different to usual (It is prop**ane**nitrile and not propannitrile)

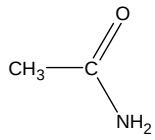
Nitriles never need a number in the name because by the functional group is always on the end of the chain

Naming Amides

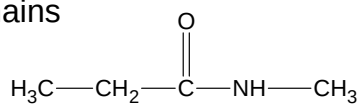
Amides are carboxylic acid derivatives.

Take the carboxylic acid name, remove the oic acid bit of the name and replace by **–amide**

ethanamide



Secondary amides are named differently to show the two carbon chains



N-methyl propanamide