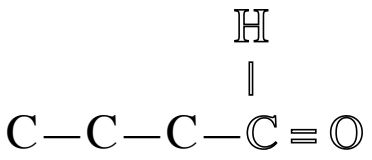
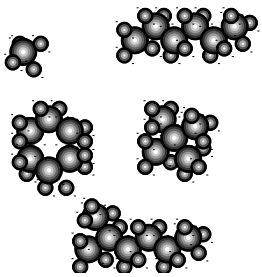
Higher Chemistry





Unit 2:

Nature's Chemistry

Student:

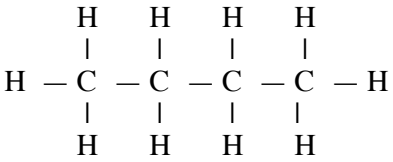
Pupil Notes Part 2

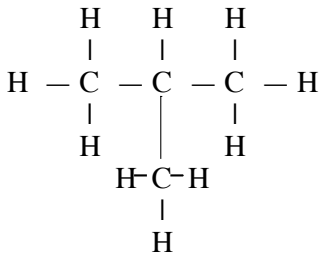
Structures & Naming

5.2 Naming Molecules

This lesson largely revises the principles behind naming and how they can be applied in more complex molecules

Naming Alkanes





This activity deals with how to name branched alkanes using systematic names, i.e. names that follow a very definite system which is based on the structure of the molecule.

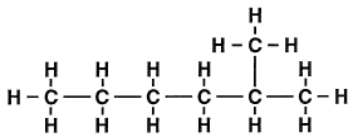
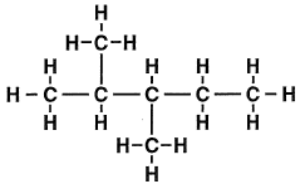
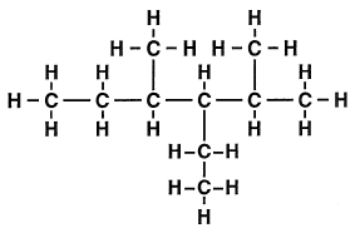
In a ***str*** ***-chain*** *hydrocarbon*, all the ***car*** atoms in the molecule are linked one after the other in a ***sin*** continuous chain.

In a ***bran*** ***-chain*** *hydrocarbon*, the molecule has one or more ***si*** ***chains*** of carbon atoms off the main chain.

Due to ***bran*** , it is possible to have *different* ***struc*** arrangements for the *same* ***mol*** *formula*. ***ane***, C_4H_{10}, has two *different* structures called ***iso*** . Clearly both of them cannot have *exactly* the same name.

Naming Rules for Alkanes

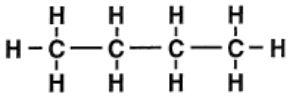
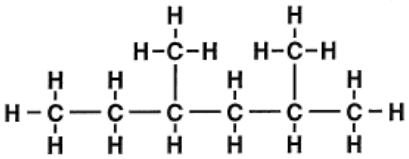
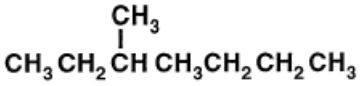
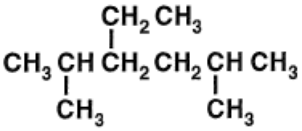
1. The ***longest chain*** defines the main chain and the last part of the name
2. ***Numbering*** of the main chain starts from the end that gives the lower overall number positions for side branches
3. ***Side branch*** names end in ***'-yl'*** and depend on the number of carbon atoms in them: *methyl* for 1 carbon, *ethyl* for 2 carbon atoms, *propyl* for 3 carbon atoms, etc.
4. ***Alphabetical*** order is used if different side branches appear in the same structure (*ethyl* before *methyl*).
5. ***Hyphens*** are used before or after numbers that come next to letters within a name (2-ethyl-3-methyl..)
6. ***Commas*** are used between numbers showing more than one of the same side branch (2,2,3-trimethyl..)

Full structural formula	***Systematic name***
	
	
	

Systematic name	*Full Structural formula*
3-methylpentane	
4,4-dimethyloctane	
5-ethyl-2-methylheptane	

Shortened Structural Formulae

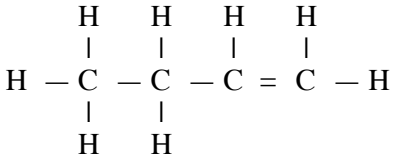
This activity is about writing and using shortened structural formulae for alkanes

Full Structural Formula	*Shortened Structural Formula*
	
	
Shortened Structural Formula	*Systematic Name*
	
	

Systematic Name	*Shortened Structural Formula*
3-methylpentane	
2,4-dimethylhexane	

Branched Alkenes

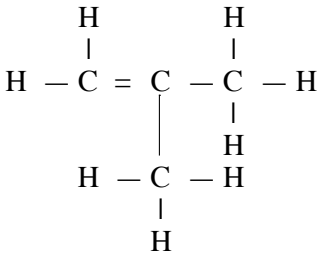
This activity considers how to use systematic names to indicate both the positions of side branches and the position of the double bond in the alkene structure.

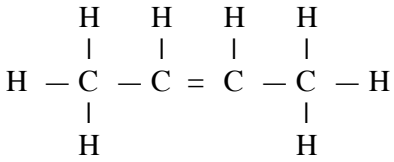


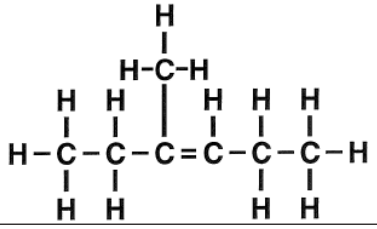
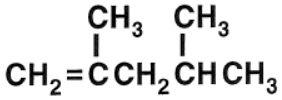
but-1-ene

There are even more ***iso*** possible in the *alkene* family. Again there are ***str*** *-chain alkenes* and ***bra*** *-chain alkenes*.

In addition, it is possible to change the ***pos*** of the ***dou*** *bond* to introduce even more *different* ***struc*** *formulae*.

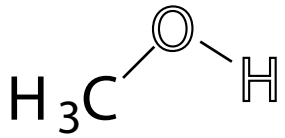




Branched Alkene Structures	
Name:	5-methyloct-2-ene
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	

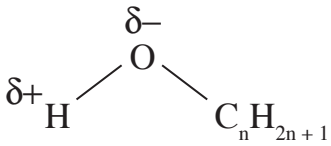
Alkanols

This activity revises the alkanol family

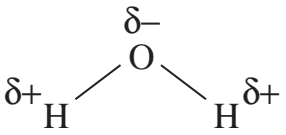


The ***func*** ***group*** in alkanols is the ***Hydr*** *group*.

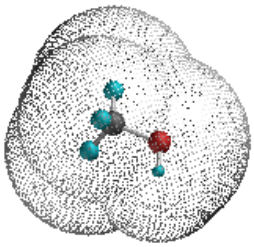
The ***alk*** can be thought of as '*substituted alkanes*' - a ***hydroc*** chain with the ***hydr*** *group* replacing one of the ***hydr*** atoms.

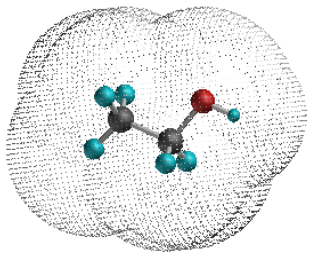


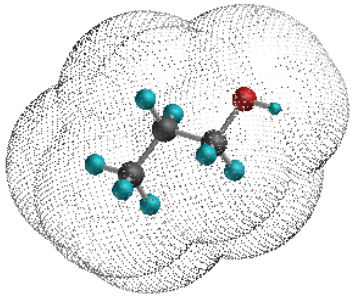
Like ***wa*** , *alkanols* are ***cov*** molecules and, as a result, are *very poor* ***cond*** of electricity.



Like ***wa*** , *alkanols* have a ***pol*** O—H bond which allows ***hyd*** *bonding* between molecules. As a result, water and smaller alkanols will '*dissolve*' in each other as the ***stre*** of their *intermolecular* forces are very ***sim*** .





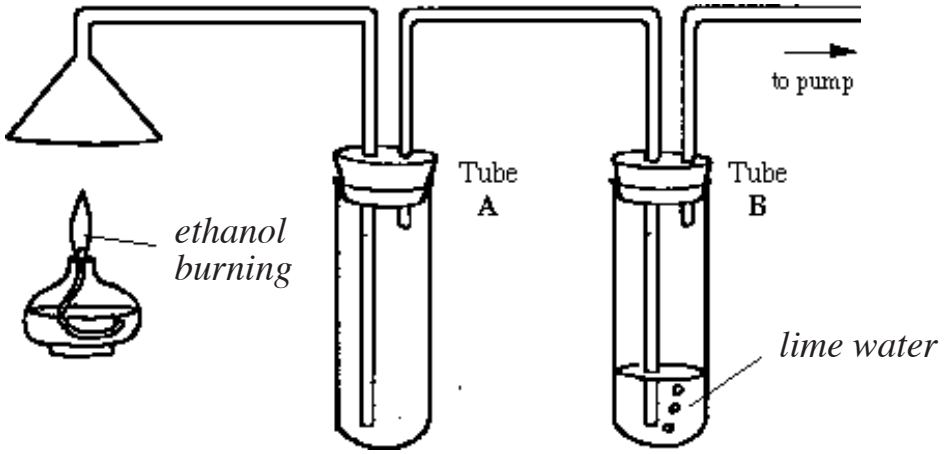


As well as sharing the same ***Gen*** ***formula***, the ***phy*** *properties* of the alkanols such as *melting point* (***inc***), *boiling point* (***inc***) and *solubility in water* (***dec***) show a steady trend as the *molecular size* increases. For these reasons, the alkanols can be described as a ***homo*** ***series***.

Property	***Result***
Appearance	
Solubility	
pH	
Conduction	
Burning	

Combustion of Ethanol

This activity is about the products of combustion reaction of ethanol



ethanol + → +

C_2H_5OH + → +

The ***comb*** of ethanol can be referred to as ***oxi*** on the basis that the ***car*** and ***hydr*** are ' *gaining oxygen* '. Later in this topic *mild oxidation* of alcohols will lead to totally different, and much more important, products - ***aldehydes***, ***ketones*** and ***carboxylic acids***.

Straight-Chain Alkanols

This activity considers how to use systematic names to indicate the position of the hydroxyl group in isomers

The position of the *hydroxyl* group can change to produce *isomers* without the need to introduce branches.

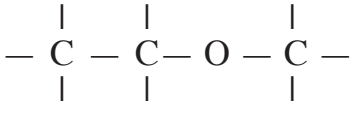
Full Structural

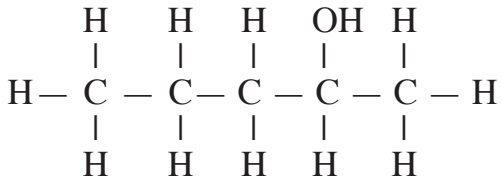
Shortened Structural

Systematic Name

C_3H_6O

Isomers don't have to be from the same homologous series



Straight-Chain Alkanols	
Name:	heptan-4-ol
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	**$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2OH$**

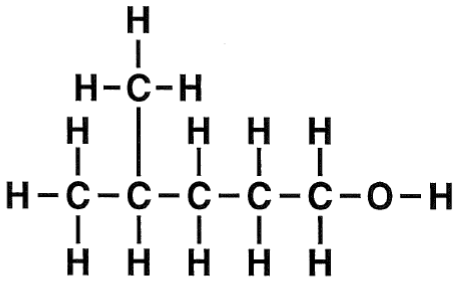
Branched-Chain Isomers

This activity considers how to use systematic names to indicate both the position of the hydroxyl group and the branch position in isomers of branched-chain alkanols

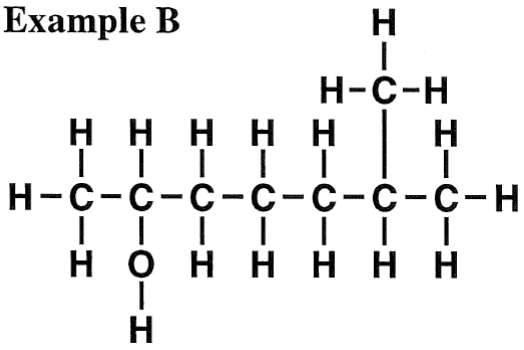
The 'longest chain' must include the functional group.

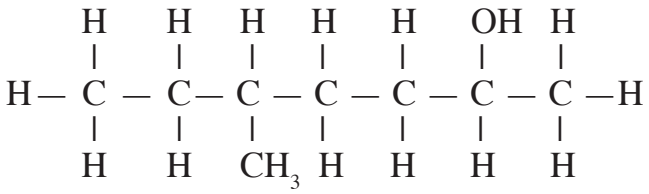
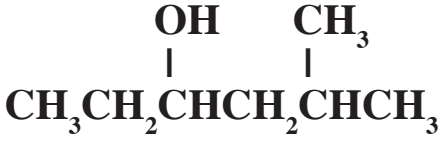
The chain is numbered from the end nearest the functional group

Example A



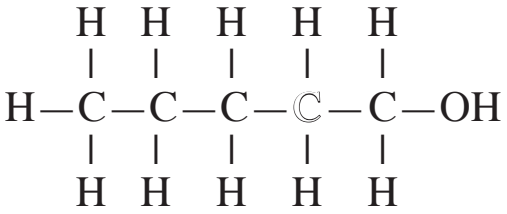
Example B



Branched-Chain Alkanols	
Name:	2-methylpentan-1-ol
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	

Primary, Secondary & Tertiary

This activity relates the classification of alcohols to their molecular structures

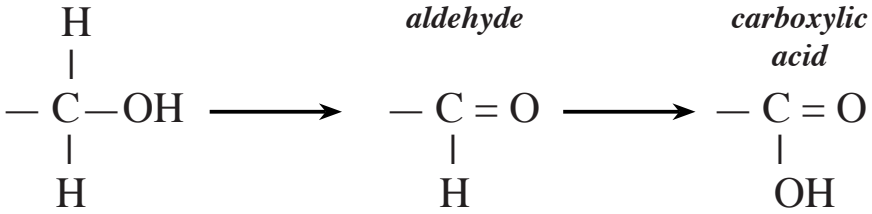


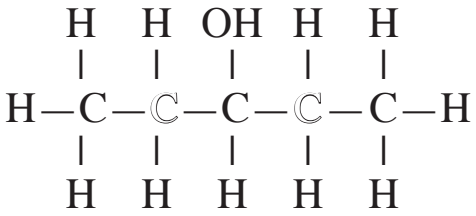
This is an example of a ***prim*** ***alcohol***.

It is so-called because only ***one car*** is directly attached to the carbon with the ***hyd*** *group*.

The ***hyd*** *group* is at the ***end of the chain***.

Systematic Name

mild oxidation : ***primary alcohol***  ***aldehyde*** ***carboxylic acid***



This is an example of a ***sec*** ***alcohol***.

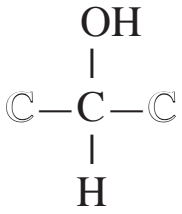
It is so-called because ***two car*** are directly attached to the carbon with the ***hyd*** *group*.

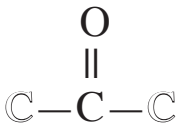
The ***hyd*** *group* is ***along the chain***.

Systematic Name

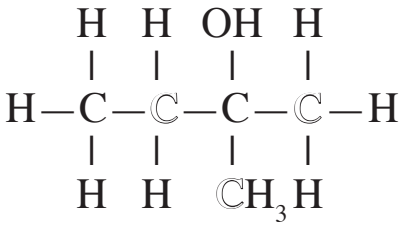
mild oxidation :

secondary alcohol





ketone



This is an example of a ***tertiary*** alcohol.

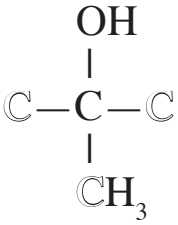
It is so-called because ***three car*** are directly attached to the carbon with the ***hyd*** *group*.

The ***hyd*** *group* is at ***a branched position*** of the chain.

Systematic Name

mild oxidation :

tertiary alcohol



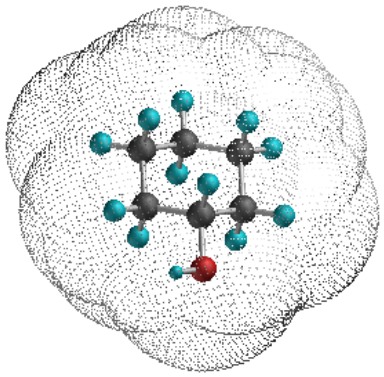
no products from mild oxidation

Ring Structures

This activity looks briefly at the structures and names of the cyclalkanols

Molecular Formula

C_4H_7OH **C_5H_9OH**



Full Structural

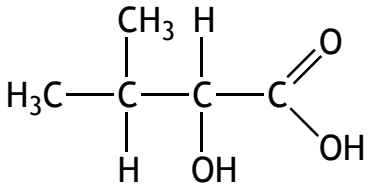
Systematic Names

Cycloalkanols are examples of ***sec*** alcohols because there are ***two car*** attached to the carbon with the ***hyd*** *group* - the hydroxyl group is 'along the chain'.

Cycloalkanols are ***not iso*** of *alkanols*, because there are ***two less hyd*** in a ring structure compared to the equivalent chain structure.

Hydroxyl Group as Substituent

This activity demonstrates how the hydroxyl group is named in molecules with more important groups present.



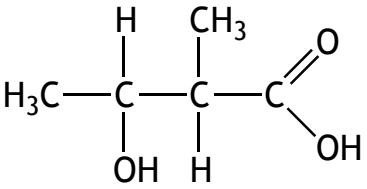
In this molecule the ***carb*** acid group, —COOH, is ***more imp*** and the presence of the —OH is signified by the use of the *prefix* '***hydroxy***' rather than the normal *suffix* '***-ol***'

2-hydroxy-3-methylbutanoic acid

Other groups that you might meet as suffixes:-

—NH_2 ***amine*** becomes ***amino***

—COOH ***carboxylic*** becomes ***carboxyl***

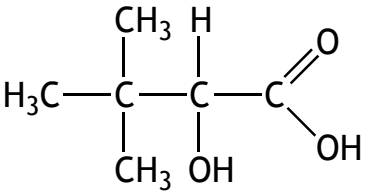


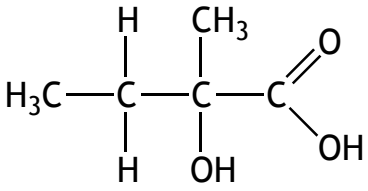
You are already familiar with:-

CH_4 ***methane*** becoming ***methyl***

But may also see:-

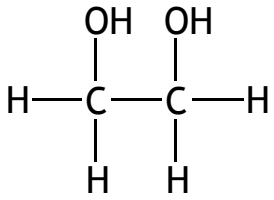
—O—CH_3 becoming ***methoxy***





More Than One Hydroxyl Group

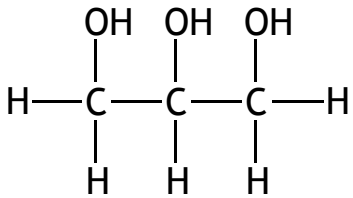
This activity looks at the structures and names of two alcohols which have more than one hydroxyl group



The common name for this alcohol is ***gly*** .

It is used as ***anti*** in car ***rad*** .

It contains *two* ***hyd*** *group* and can be referred to as a ***dih*** alcohol or a ***diol***.



The common name for this alcohol is ***gly*** .

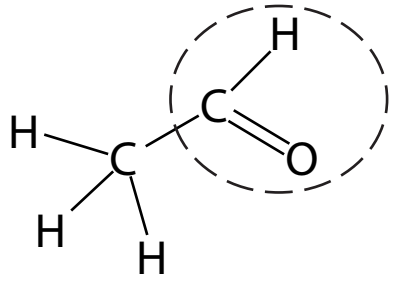
It has various culinary uses including ***ice-c***

It contains *three* ***hyd*** *group* and can be referred to as a ***trih*** alcohol or a ***triol***.

Aldehyde Structures

This activity considers the structures and systematic names of the alkanal series of aldehydes.

*An **alkanal** is a compound which contains the **carbonyl** group at the end position of a hydrocarbon chain in which all the carbon atoms are linked by single bonds.*

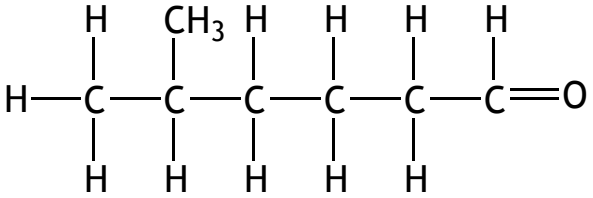


The ***func*** *group* of an aldehyde contains the ***car*** *group* and a ***hyd*** atom - —CHO.

CH_3CHO

The longest carbon chain includes the ***func*** *group*, so this molecule is named as ***al***.

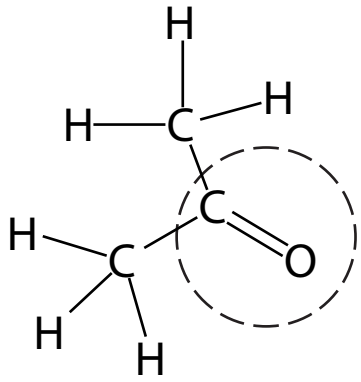
The chain is always numbered from the end with the —CHO functional group.

Alkanal Structures	
Name:	2-methylpropanal
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	CH_3 $CH_3CH_2CHCH_2CH_2CH_2CH_2CHO$

Ketone Structures

This activity considers how to apply systematic names to the alkanone family of ketones.

*An **alkanone** is a compound which contains the **carbonyl** group at a position within a hydrocarbon chain where all the carbon atoms are linked by single bonds.*

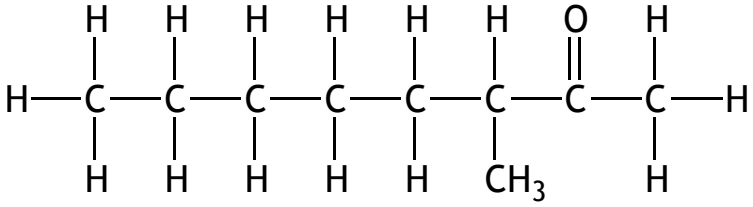


The ***func*** *group* of a ketone is simply the ***car*** *group* by itself.

CH_3COCH_3

The longest carbon chain must include the ***func*** *group*. This molecule is named as ***one***.

The chain is always numbered from the end nearest the —CO— functional group.

Alkanone Structures	
Name:	4-methylhexan-2-one
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	$CH_3CH_2CHCOCH_2CH_3$ with CH_3 branch

Alkanoic acids

This activity considers the structures, formulae and systematic names of some of the members of the alkanoic acid family.

Any molecule that contains the *carb group*, —COOH, can be considered as a *carboxylic acid*. The molecule could have a ***cha*** structure, a ***ri*** structure, it could be ***urated*** (C—C) or ***urated*** (C=C or C≡C).

*The **alkanoic acids** are compounds which contain the **carboxyl group** joined to a hydrocarbon **chain** in which all the carbon atoms are joined by **single** bonds.*

As usual, there are three ways to represent the formula of, for example, *pentanoic acid*

full structural formula

shortened structural formula

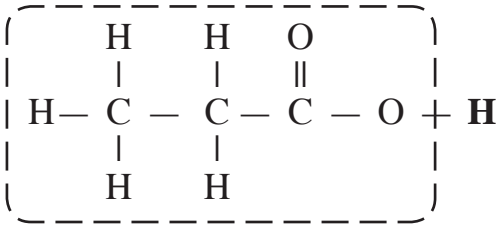
functional molecular formula

For naming purposes, the ***car*** of the ***car*** ***func*** *group* is always taken as number 1, and the *'longest'* chain always starts with the ***func*** *group*. For example:

4-methylpentanoic acid ***2-ethylbutanoic acid*** ***2,2-dimethylpropanoic acid***

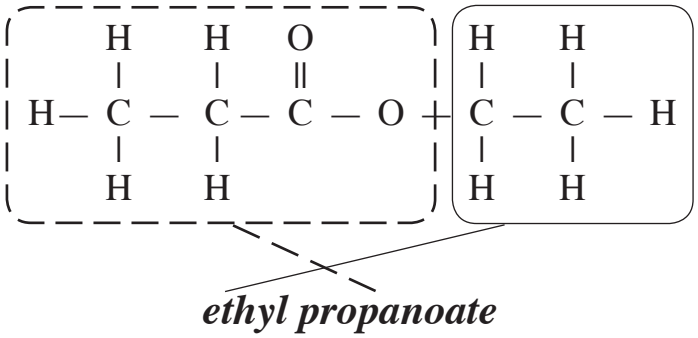
Simple Esters

This activity deals with naming and drawing full and structural formulae for esters.



The 'best'way to think about an ***es*** is to consider it as an ***ac*** ***molecule*** which has had its ***hydr*** ***atom*** replaced by a ***car*** ***chain*** (an *alkyl group*).

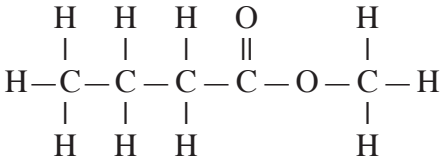
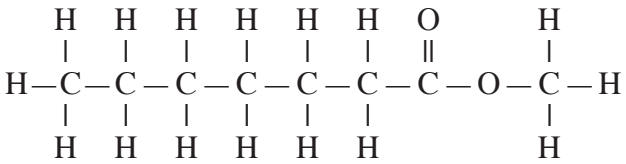
Learn to draw acids and you should find esters easy.



ethyl propanoate

As is often the case, we 'start' at the end of the name. *Identify the acid* (look for the ***carb*** C = O) and give the ***est*** its ***surn*** by changing the *—oic* ending to ***—oate***.

The *carbon chain* (derived from the parent ***alc***) is the ***'chr*** ***' name***, *—ol* changed to ***—yl***.

Ester Structures & Names	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	
Name:	pentyl propanoate
Full Structural Formula:	
Shortened Structural Formula:	
Name:	
Full Structural Formula:	
Shortened Structural Formula:	$CH_3CH_2CH_2COOCH_2CH_2CH_2CH_3$
Name:	
Full Structural Formula:	
Shortened Structural Formula:	