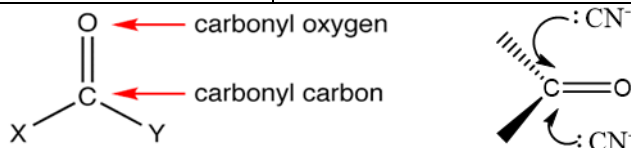


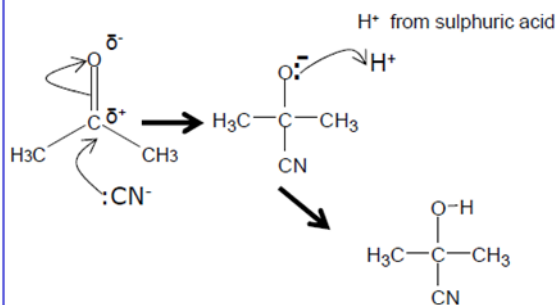
# Isomerism and carbonyl compounds Knowledge organiser

## 1. Keywords

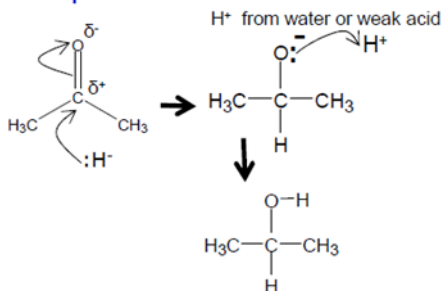
Dipole-dipole forces :	attractive forces between the positive end of one polar molecule and the negative end of another polar molecule
Electronegativity:	is a measure of an atom's ability to attract shared electrons to itself
Racemic mixture (racemate)	Mixture that has equal amounts of left- and right-handed enantiomers of a chiral molecule.



### Nucleophilic Addition Mechanism



### Nucleophilic Addition Mechanism



## 2. Nomenclature

The carbonyl group is present in aldehydes (RCHO) and ketones (RCOR'). They are both represented by the general formula  $C_nH_{2n}O$ .

- Aldehydes (-al suffix) can only be at the end of a molecule so there is no need to provide numbering their functional group.
- No ketone (-one suffix) can have less than 3 carbons. So you don't need to number the carbonyl group in propanone or butanone

## 3. Physical properties

The big difference in **electronegativity** between carbon and oxygen, makes the C=O bond strongly polar. There are permanent **dipole-dipole** forces between the molecules.

Shorter chains carbonyl compounds are readily soluble in water since they form hydrogen bonds with water. As the aryl/alkyl chain lengthens solubility decreases.

Methanal is a gas at room temperature. Short carbonyl compounds are liquids.

## 4. Reactivity

Most reactions involve the C=O bond because it is strongly polar.

Nucleophilic addition reaction:

- The reaction with NaCN and dilute HCl is very important since it increases the length of the carbon chain by one carbon.
- This reaction will produce a **racemic mixture (racemate)** of hydroxynitriles.
- If performed on ethanol and followed by and hydrolysis with HCl it will produce a racemate of lactic acid.

Oxidation:

Aldehydes can be oxidised to carboxylic acids.

Reduction (another nucleophilic addition reaction) :

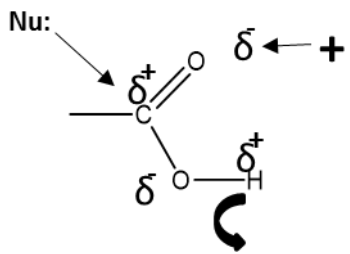
Many reducing agent will reduce carbonyl groups to alcohols. Once reducing agent is sodium tetrahydridoborate(III) ( $NaBH_4$ ) which provides a source of hydrogen to act as a nucleophile creating the H- (hydride ion).

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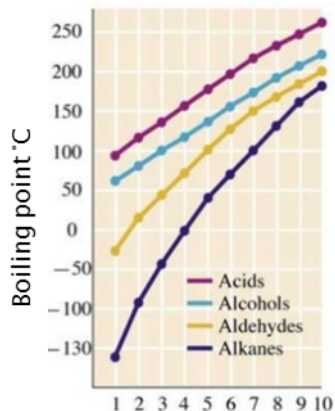
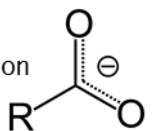
## 1. Keywords

Delocalisation:

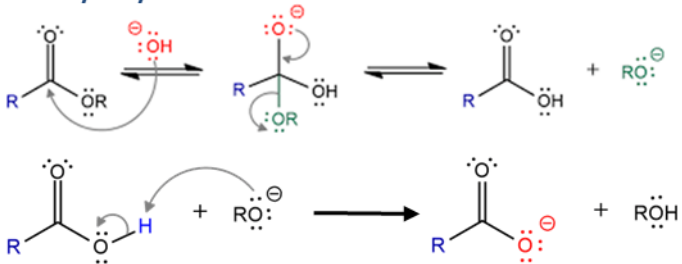
when electrons in a molecule, ion or solid metal that are not associated with a single atom or a covalent bond.



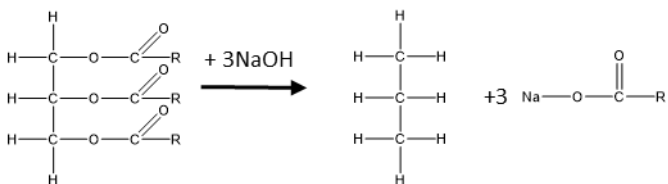
Charge delocalisation



## Base hydrolysis



## Glycerol base hydrolysis (saponification)



## 2. Carboxylic acids

Carboxylic acids (RCOOH) have two functional groups:  
Carboxyl group

Hydroxy group

Nomenclature:

- Suffix: -oic acid

- The functional group always ends the chain and is included in carbon chain of the root name if the acid is not attached to a benzene ring.

- Numbering starts from the carboxyl -COOH carbon.

Physical properties:

Acids are able to form hydrogen bonds also in their solid states that's why they have higher boiling points than the respective alkanes.

Reactivity:

- Due to electronegativity the -OH group in acids is more acidic than alcohols, carboxylic acids are weak acids, so they form an equilibrium when they dissociate.

- They undergo the same chemical reactions as any inorganic acid acting as proton donors, the carboxylate ion

## 3. Esters

Nomenclature:

- Esters (RCOOR') are derived from the reaction between carboxylic acids and alcohols in the presence of a strong acid acting as a catalyst.

- The name of the esters are based on that of the parent acid but the name always begins with the alkyl or aryl group that has replaced the hydrogen of the acid;

Physical properties:

- Short esters are volatile and have pleasant fruity smells and are used in perfumes or as flavourings.

- They are also use as solvent and plasticisers.

- Fats and oils are esters with longer carbon chains.

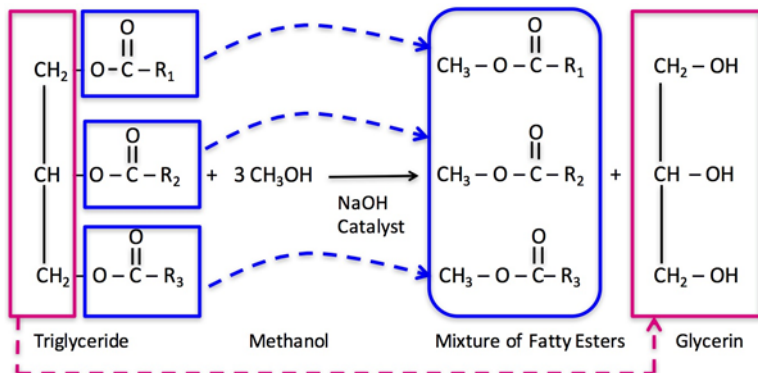
Reactivity:

- Formation see above. •Hydrolysis to acid and alcohol:

- Acidic: can occur at room temperature with a strong acid as a catalyst, the reaction does not go to completion.

- Base: in the presence of a base the salt of the acid is produced and the reaction goes to completion

# Isomerism and carbonyl compounds Knowledge organiser



## 1. Biodiesel

Biodiesel is a renewable fuel obtained from oils, mainly rape seed oil.

- Triglycerides are reacted with methanol in the presence of a strong alkali as a catalyst to form methyl esters and glycerol.

### Uses of Glycerol

Glycerol is able to form many hydrogen bonds and it is very soluble in water so it has extensive applications:

- Used in creams and ointments to prevent their drying
- Solvent in the food industry, medicines and toothpastes
- Plasticiser.

## 2. Acylation (Addition- elimination reaction)

- Acylation is the addition of the acyl group (-COR) into another molecule.
- Acid derivatives all have the acyl group as part of their structure.
- The acid derivative is polarized and its carbonyl group can be attacked by a nucleophile, the nucleophile gets acylated.

-Z	Name of acid derivative	General formula	Example
-OR	ester	RCOOR'	Ethyl ethanoate CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub>
-Cl	acyl chloride	RCOCl	Ethanoyl chloride, CH <sub>3</sub> COCl
-OCOR'	acid anhydride	RCOOCOR'	Ethanoic anhydride, CH <sub>3</sub> COOCOCH <sub>3</sub>

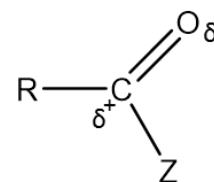
Addition- elimination reaction depends on:

The polarization of the acid derivative depends on the electron-releasing or attracting power of Z./ How good Z is leaving group / How good the nucleophile is.

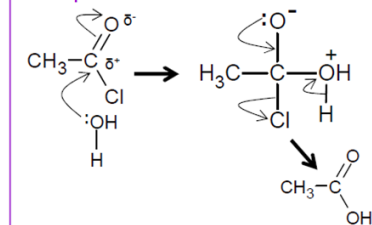
Ethanoic anhydride is used as an acylating agent over ethanoyl chloride because:

- It is cheaper
- It is less corrosive
- It is safer as the by-product is ethanoic acid rather than hydrogen chloride.

Acid derivative general formula



### Nucleophilic Addition - Elimination Mechanism



← Increasing reactivity

	Acyl chloride 	Acid anhydride 
Ammonia NH <sub>3</sub>	amide 	amide 
Amine R'-NH <sub>2</sub>	N-substituted amide 	N-substituted amide 
Alcohol R'-OH	ester 	ester 
Water H <sub>2</sub> O	carboxylic acid 	carboxylic acid 

Increasing reactivity of nucleophile ↑