Chemistry Level 3: Organic Chemistry

Naming Compounds

What you need to know:

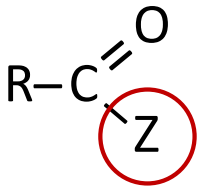
Optical Isomers (enantiomers):

"Mirror-image isomers" where 4 DIFFERENT groups are attached to 1 carbon

SAME physical and chemical properties, EXPEPT, they rotate a plane of polarised light in different directions

New compounds:

Carboxylic Acids -anoic acid	—CO OH
Acyl Chloride -oyl chloride	— CO Cl
Ester **R'** -yl **R** -anoate	—CO O—
Amide -amide	— CO NH_2
Aldehyde - anal	—CO H
Ketone -one	—CO—



Video Summaries

Reaction Types

What you need to know:

Acyl Chlorides
Undergoes substitution to give **CARBOXCYLIC ACID**
$Acyl\ chloride + water \rightarrow \boldsymbol{carboxylic\ acid} + HCl$

Undergoes substitution to give **ESTERS**
$Acyl\ chloride + alcohol \rightarrow \boldsymbol{ester} + HCl$

Undergoes substitution to give **AMIDES**
$Acyl\ chloride + ammonia \rightarrow \boldsymbol{primary\ amide} + ammonium\ choloride\ salt$
$Acyl\ chloride + primary\ amide \rightarrow \boldsymbol{2°\ amide} + ammonium\ chloride\ salt$

Esters
Undergoes substitution to give **amide plus alcohol**
$Ester + NH_3 \rightarrow \boldsymbol{amide} + alcohol$

Undergoes substitution to give **carboxylic acid + alcohol**
$Ester + water \rightarrow \boldsymbol{carboxylic\ acid} + alcohol$
This is called **ACID HYDROLYSIS**

Undergoes substitution to give **carboxylic acid salt + alcohol**
$Ester + water \rightarrow \boldsymbol{carboxylic\ acid\ salt} + alcohol$
This is called **BASE HYDROLYSIS / SAPONIFICATION**

Amides
Substitution reaction is hydrolysis to give acid OR base
$Acid\ hydrolysis \xrightarrow[heat]{H_3O^+} carboxylic\ acid$

This is called **ACID HYDROLYSIS**

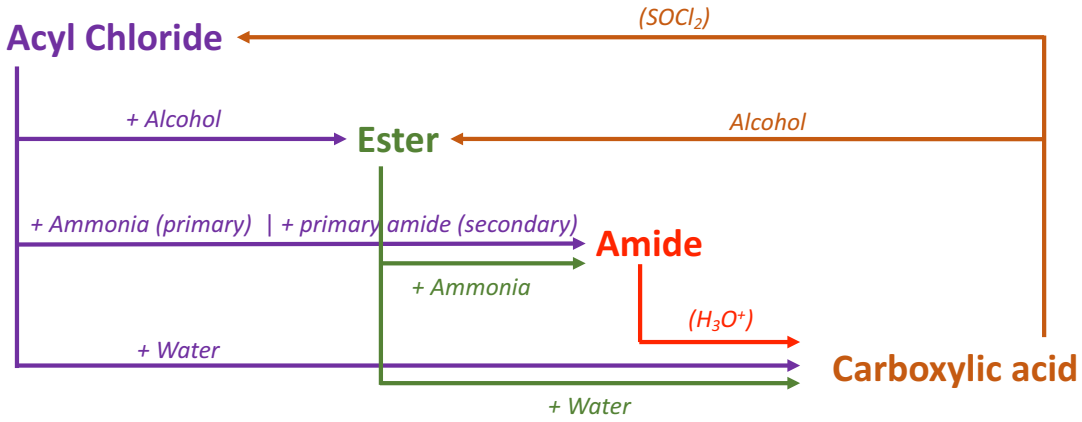
Substitution reaction is hydrolysis to give acid OR base
$Base\ hydrolysis \xrightarrow[OH^-]{Heat} acid\ salt + ammonia$
This is called **BASE HYDROLYSIS**

Carboxylic acids
Undergoes two reactions that are the reverse of reactions already learned.

ESTERIFICATION and condensation to form an ester and water
$carboxylic\ acid + alcohol \rightarrow ester + water$

Nucleophilic substitution to form an acyl chloride
$Nucleophilic\ substitution\ to \rightarrow acyl\ chloride$

Reaction Types



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Video Summaries

Polymerisation

what you need to know

Polymerisation	Formed by	Other
Polyester	Dicarboxylic acid + diol Diacylchloride + diol	
Polyamide	Carboxcylic acid + diamine	Undergo acid hydrolysis
Polypeptides (Proteins)	Amino acids	

Esters

Triglyceride (ester)	Long chain carboxylic acid (fatty acids) + 1,2,3-triol	Called fats and oils
Soap (salt)	Triglyceride + NaOH	Formed by base hydrolysis of an ester

Oxidation and Reduction

What you need to know

Oxidation ($H^+/MnO_4{}^{2-}$ *or* $H^+/Cr_2O_7{}^{-2}$)

$1° \; alcohol \rightarrow aldehyde \rightarrow carboxylic\ acid$
$2° \; alcohol \rightarrow ketone \not\rightarrow$
$3° \; alcohol \not\rightarrow$

$aldehyde \rightarrow carboxylic\ acid$
$ketone \not\rightarrow$

Reduction ($NaBH_4$)

$aldehyde \rightarrow 1° \; alcohol$
$ketone \rightarrow 2° \; alcohol$

	$1° \; alcohol$	$2° \; alcohol$	$3° \; alcohol$
$H^+/Cr_2O_7{}^{-2}$	orange → green	orange → green	no change
$H^+/MnO_4{}^{2-}$	Purple → colourless	Purple → colourless	no change
Lucas	No change	cloudy after 10 mins	cloudy immediately

	Aldehyde	***Ketone***
$MnO_4{}^{2-}/Cr_2O_7{}^{-2}$	colour change	no change
Tollens regeant	silver mirror forms	no change
Fehlings solution	red brown ppt	no change

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Video Summaries

Lab Techniques

What you need to know

Apparatus	Used for	Example
Separating funnel	Separating compounds based on solubility. The more dense bottom layer can be run off (or less dense poured off).	Separating ester and water. Insoluble, so separate in funnel.
Distillation	Separating (purifying) products from reactants. Uses different boiling points of compounds.	To get aldehyde from 1° alcohol.
Fractional distillation	Separates mixtures based on boiling points.	
Filtration	Removing of solids from liquids.	Removing a drying agent (we will cover this later)
Reflux	Speed up or cause organic reaction to occur without losing volatile compounds.	Acid + base hydrolysis of ester

Reagent	Use	Example
Sodium carbonate solution Na_2CO_3 OR Sodium hydrogen carbonate solution $NaHCO_3$	Remove or neutralise acid	Unreacted concentrated HCl when $3° \; alcohol \rightarrow haloalkane$
Calcium chloride $CaCl_2$ OR Sodium suphite Na_2SO_4	Remove H_2O	In above reaction, remove traces of H_2O after separating off aqueous layer

Reaction Schemes

From Level 2

Addition reactions

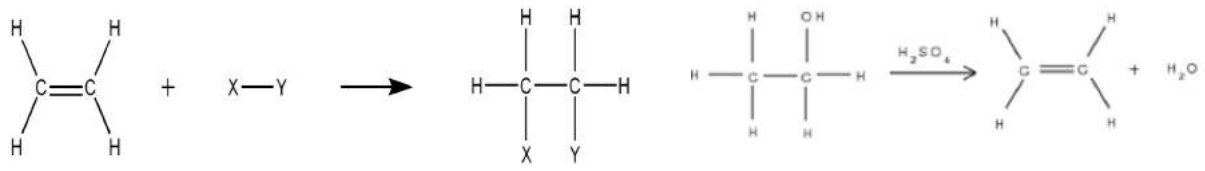
- Addition is breaking a double bond (fast)

Alkenes

- Hydration (H_2O) → alcohol
- Hydrogenation (H_2/Pt) → alkane
- Halogenation (Br_2, Cl_2, HCl, HBr) → haloalkane
- Markovnikov's Rule (HBr, HCl) (the rich get richer) – produces major and minor products

Elimination reactions

- This is making a double bond
- Concentrated H_2SO_4 is the reagent used for elimination reactions
- Alcohol → Alkene (H_2O produced)
- Haloalkane → Alkene (hydrogen halide – HCl, HBr – produced)



Reaction Schemes

From Level 3

We have learned new reactions in this achievement standard: oxidation, reduction and substitution

Oxidation

1° alcohol	→ aldehyde → carboxylic acid	MnO_4^- $Cr_2O_7^{2-}$	Colour change
2° alcohol	→ ketone	MnO_4^- $Cr_2O_7^{2-}$	

Reduction

aldehyde	→ 1° alcohol	$NaBH_4$
ketone	→ 2° alcohol	$NaBH_4$

Reaction Schemes

Substitution

Acyl halide	→ carboxylic acid	H_2O	
	→ ester	$alcohol$	condensation
	→ 1° amide	$NH_3\ (alc)$	
	→ 2° amide	$amine$	
Ester *(always forms two compounds)*	→ amide + alcohol	$NH_3\ (alc)$	
	→ carboxylic acid + alcohol	H^+/H_2O	acid hydrolysis
	→ carboxylic acid salt + alcohol	$NaOH_{(aq)}$	base hydrolysis
Amide	→ carboxylic acid	HCl	acid hydrolysis
	→ acid salt	$NaOH_{(aq)}$	base hydrolysis
Carboxylic acid	→ ester	$alcohol\ (H_2SO_4)$	Esterification /condensation
	→ acyl chloride	$SOCl_2$	

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