



# Cambridge (CIE) A Level Chemistry



## Characteristic Organic Reactions

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- \* Organic Chemistry Terminology



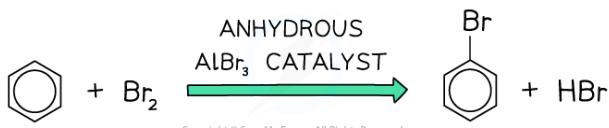
# Organic Chemistry Terminology

- Organic reactions are often associated with **terminology** students should be familiar with
- Two of these important terms include:
  - Electrophilic substitution
  - Addition-elimination

## Electrophilic substitution

- **Electrophiles** are species that are **electron deficient** and can act as an **electron pair acceptor**
  - Electrophiles are 'electron loving' species
- **Substitution reactions** are reactions that involve the replacement of one atom or group of atoms by another
- Electrophilic substitution reactions are therefore reactions in which an atom or group of atoms are **replaced** by an **electrophile** after an initial attack by the electron-deficient species
- An example of an electrophilic substitution reaction is the reaction of **benzene** with **bromine** in the presence of **anhydrous aluminium bromide catalysts**
  - The bromine acts as an **electrophile** and attacks the **electron-rich benzene ring**
  - A hydrogen atom is substituted by a bromine atom to form bromobenzene and hydrogen bromide
- Benzene undergoes substitution reactions rather than addition reactions because of the stability of the benzene ring

## Electrophilic substitution of benzene by bromine



A hydrogen atom in benzene is substituted by a bromine atom, which acts as an electrophile

## Addition-elimination

- **Acyl chlorides** are **reactive** organic compounds that undergo many reactions such as **nucleophilic addition-elimination** reactions



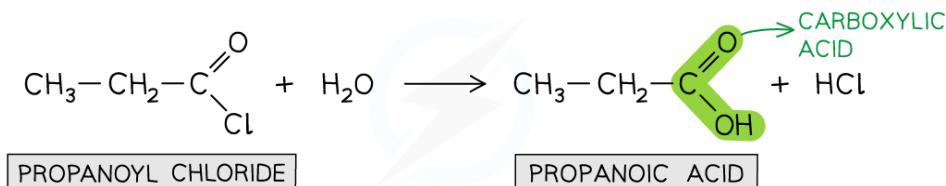
Your notes

- In nucleophilic addition-elimination reactions, the **nucleophilic addition** of a small molecule across the C=O bond takes place followed by **elimination** of a small molecule
- Examples of these nucleophilic addition-elimination reactions include:
  - Hydrolysis**
  - Reaction with alcohols to form **esters**
  - Reaction with ammonia and primary amines to form **amides**

## Hydrolysis

- The **hydrolysis** of acyl chlorides results in the formation of a **carboxylic acid** and **HCl** molecule
- This is a **nucleophilic addition-elimination** reaction
  - A **water molecule** adds across the C=O bond
  - A hydrochloric acid (HCl) molecule is **eliminated**

### Hydrolysis of propanoyl chloride to form propanoic acid and HCl

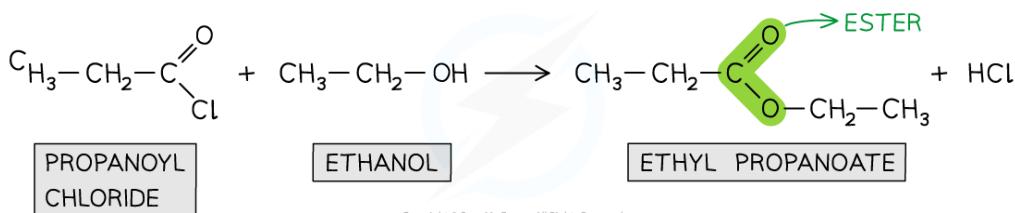


Acyl chlorides are hydrolysed to carboxylic acids via nucleophilic addition-elimination

## Formation of esters

- Acyl chlorides can react with **alcohols** to form esters
- The esterification of acyl chlorides is also a **nucleophilic addition-elimination** reaction
  - The alcohol adds across the C=O bond
  - A HCl molecule is eliminated

### Esterification of propanoyl chloride to form ethyl propanoate and HCl

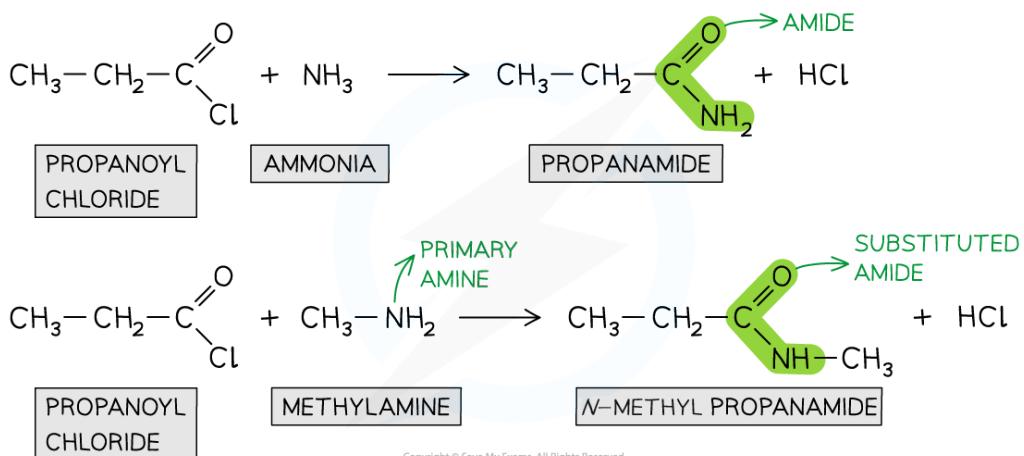




## Formation of amides

- Acyl chlorides can form **amides** with **primary amines** and **concentrated ammonia**
- The nitrogen atom in ammonia and primary amine has a lone pair of electrons which can be used to attack the carbonyl carbon atom in the acyl chlorides
- The product is an amide (when reacted with ammonia) or **N-substituted** amide (when reacted with primary amines)
- This is also an example of a **nucleophilic addition–elimination** reaction as
  - The amine or ammonia molecule adds across the C=O bond
  - A HCl molecule is eliminated

### Forming amides from propanoyl chloride



Acyl chlorides undergo reactions with ammonia and primary amines to form amides via nucleophilic addition–elimination