A-LEVEL CHEMISTRY • EXERCISE SHEET

33.3 Acyl chlorides

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS acyl chlorides 酰氯 • addition–elimination 加成消去 • amide 酰胺 • ammonia 氨 • amine 胺

Objective

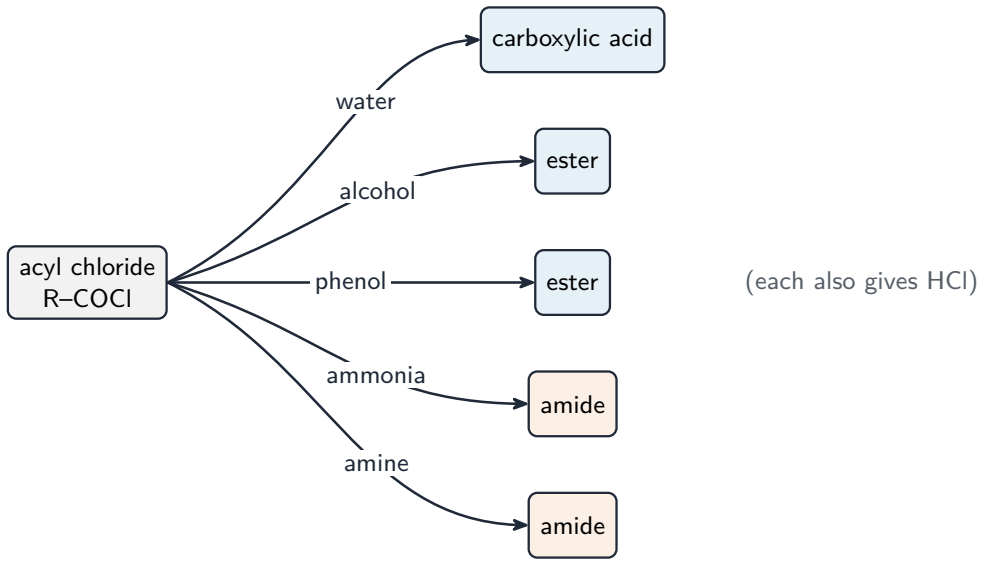
Build the skills to answer exam questions on **acyl chlorides** 酰氯 — their reactions, the **addition–elimination** 加成消去 mechanism, and the order of ease of **hydrolysis** 水解.

You must be able to:

- give the products of an acyl chloride with water, alcohols, phenol, ammonia and amines
- describe the addition–elimination mechanism
- explain the order acyl chloride ≫ alkyl chloride ≫ aryl chloride

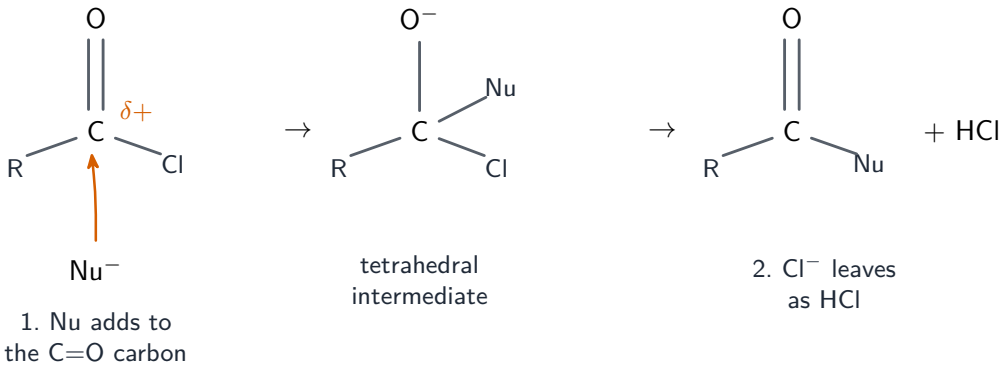
1 Worked examples

■ Reactions and mechanism



Acyl chlorides are very reactive: with water, an alcohol, phenol, ammonia or an amine they give the labelled product + HCl

Reactant	Product (+ HCl)
water	carboxylic acid
alcohol / phenol	ester
ammonia	amide
amine	(N-substituted) amide



Addition–elimination: the nucleophile adds to the δ+ carbonyl carbon, then C=O reforms and Cl^- leaves as HCl

2 Practice

2.1 Name the product when ethanoyl chloride reacts with water. [1]

2.2 Name the type of mechanism by which acyl chlorides react. [1]

3 Exam-style questions

3.1 Ethanoyl chloride reacts with ammonia to give: [1]

- **A** an ester
- **B** ethanamide
- **C** ethanoic acid
- **D** an amine

3.2 Which order of ease of hydrolysis is correct? [1]

- **A** aryl chloride ≫ alkyl chloride ≫ acyl chloride

- **B** acyl chloride ≫ alkyl chloride ≫ aryl chloride
- **C** alkyl chloride ≫ acyl chloride ≫ aryl chloride
- **D** they hydrolyse equally easily

3.3 Describe the **addition–elimination** mechanism for the reaction of ethanoyl chloride with an alcohol. [3]

3.4 Explain why an acyl chloride is hydrolysed far more easily than an aryl chloride (e.g. chlorobenzene). [2]

Solutions

2.1 ethanoic acid.

2.2 addition–elimination (nucleophilic).

3.1 B. Acyl chloride + ammonia → amide (ethanamide) + HCl.

3.2 B. Acyl chloride ≫ alkyl chloride ≫ aryl chloride.

3.3 the nucleophile (the alcohol's O lone pair) adds to the slightly positive carbonyl carbon, forming a tetrahedral intermediate; the C=O double bond reforms; the C–Cl bond breaks and HCl is eliminated, giving the ester.

3.4 the carbonyl carbon of an acyl chloride is strongly $\delta+$ and easily attacked by a nucleophile; in an aryl chloride the C–Cl bond is strengthened by overlap with the ring and the ring repels nucleophiles, so it resists hydrolysis.