Exercise walk-through

Acyl chlorides ▪ 33.3

eXercise

You must be able to

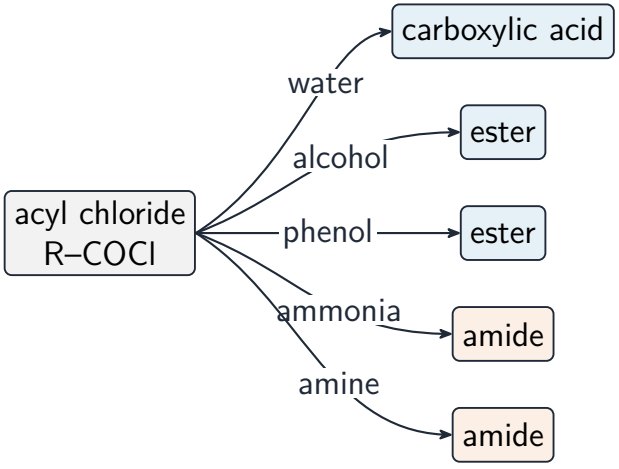
- give the products of an acyl chloride with water, alcohols, phenol, ammonia and amines
- describe the addition–elimination mechanism
- explain the order acyl chloride alkyl chloride aryl chloride

Method — Reactions and mechanism

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

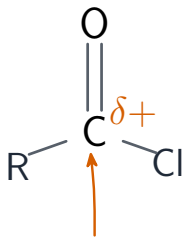
Reactant	**Product (+ HCl)**
water	carboxylic acid
alcohol / phenol	ester
ammonia	amide
amine	(N-substituted) amide

Method — Reactions and mechanism

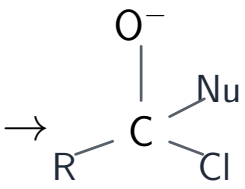


(each also gives HCl)

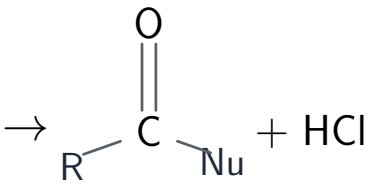
Method — Reactions and mechanism



1. Nu adds to the C=O carbon



tetrahedral intermediate



2. Cl^- leaves as HCl

Practice 2.1 ▪ 1 mark

Name the product when ethanoyl chloride reacts with water.

Solution 2.1

Method: Reactions and mechanism

Worked steps

ethanoic acid B1.

Practice 2.2 ▪ 1 mark

Name the type of mechanism by which acyl chlorides react.

Solution 2.2

Method: Reactions and mechanism

Worked steps

addition–elimination (nucleophilic) B1.

Exam-style 3.1 ▪ 1 mark

Ethanoyl chloride reacts with ammonia to give:

A an ester

B ethanamide

C ethanoic acid

D an amine

Solution 3.1

Method: Reactions and mechanism

A an ester

B ethanamide ✓

C ethanoic acid

D an amine

Worked steps

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

Exam-style 3.2 ▪ 1 mark

Which order of ease of hydrolysis is correct?

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

Solution 3.2

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

Worked steps

B. Acyl chloride alkyl chloride aryl chloride.

Exam-style 3.3 ▪ 3 marks

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

Solution 3.3

Method: Reactions and mechanism

Worked steps

the nucleophile (the alcohol's O lone pair) adds to the slightly positive carbonyl carbon, forming a tetrahedral intermediate M1; the C=O double bond reforms M1; the C–Cl bond breaks and HCl is eliminated, giving the ester A1.

Exam-style 3.4 ▪ 2 marks

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

Solution 3.4

Method: Reactions and mechanism

Worked steps

the carbonyl carbon of an acyl chloride is strongly $\delta+$ and easily attacked by a nucleophile **M1**; in an aryl chloride the C–Cl bond is strengthened by overlap with the ring and the ring repels nucleophiles, so it resists hydrolysis **A1**.