A-LEVEL CHEMISTRY • EXERCISE SHEET

34.3 Amides

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS amides 酰胺 • hydrolysis 水解 • amine 胺 • reduction 还原 • ammonia 氨

Objective

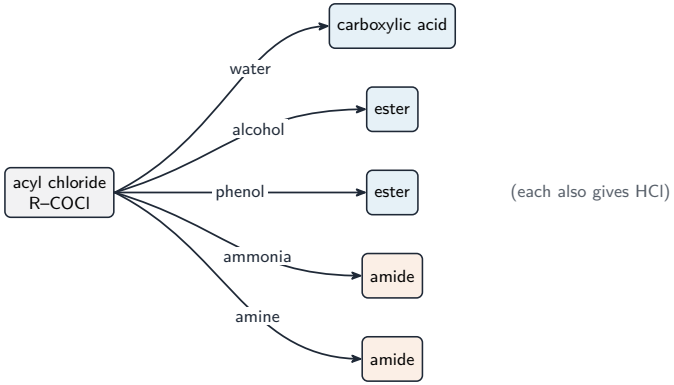
Build the skills to answer exam questions on **amides** 酰胺 — making them, their **hydrolysis** 水解 and reduction, and why an amide is a very weak base.

You must be able to:

- make an amide from an acyl chloride and ammonia/an amine
- give the products of acid and alkaline hydrolysis of an amide
- explain why an amide is a much weaker base than an amine

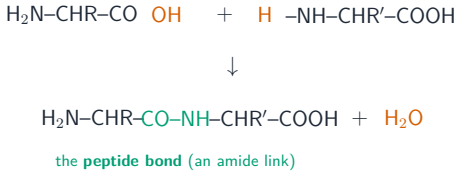
1 Worked examples

■ Reactions of amides



(each also gives HCl)

An amide is made from an acyl chloride with ammonia or an amine (+ HCl)



Amides include the peptide bond

- **make it:** acyl chloride + NH_3 (or amine) → amide + HCl.
- **acid hydrolysis:** amide + H^+/water → carboxylic acid + ammonium salt.
- **alkaline hydrolysis:** amide + OH^- → carboxylate salt + ammonia.
- **reduction:** $LiAlH_4$ reduces the C=O to give an amine.
- an amide is a **very weak base** — its N lone pair is delocalised onto the C=O, so it cannot accept an H^+.

2 Practice

2.1 Give the two reagents used to make ethanamide. [2]

2.2 Name the organic product of reducing ethanamide with $LiAlH_4$. [1]

3 Exam-style questions

3.1 Acid hydrolysis of ethanamide gives ethanoic acid and: [1]

- **A** ethylamine
- **B** an ammonium salt
- **C** ethanol
- **D** ethene

3.2 An amide is a much weaker base than an amine because the nitrogen lone pair is: [1]

- **A** removed completely
- **B** delocalised onto the adjacent C=O group
- **C** used in a C–H bond
- **D** more available

3.3 Ethanamide is hydrolysed by hot aqueous NaOH.

(a) Name the two products. [2]

(b) Write the equation. [2]

3.4 Explain why ethanamide is a far weaker base than ethylamine. [2]

3.5 *N*-methylethanamide, $CH_3CONHCH_3$, is a secondary amide.

(a) Name the two compounds that react together to make it, and state why an acyl chloride is preferred to the carboxylic acid. [3]

(b) The amide is refluxed with (i) dilute hydrochloric acid and (ii) aqueous sodium hydroxide. Give the organic products in each case. [4]

(c) The amide is reduced with $LiAlH_4$ in dry ether. Name the product and give the equation using [H]. [2]

(d) Explain why an amide is a far weaker base than an amine. [3]

Solutions

2.1 ethanoyl chloride; ammonia, NH_3.

2.2 ethylamine.

3.1 B. Acid hydrolysis gives ethanoic acid and an ammonium salt.

3.2 B. The N lone pair is delocalised onto the neighbouring C=O group.

3.3 (a) sodium ethanoate and ammonia.
(b) $CH_3CONH_2 + NaOH \rightarrow CH_3COONa + NH_3$.

3.4 in ethanamide the nitrogen lone pair is delocalised onto the C=O group; so it is not available to accept an H^+, whereas in ethylamine the lone pair is fully available.

3.5 (a) Ethanoyl chloride and methylamine; the acyl chloride reaction is fast and goes to completion, whereas the carboxylic acid would simply form an ammonium salt in an acid–base reaction.
(b) (i) With acid: **ethanoic acid** and the salt **methylammonium chloride**. (ii) With alkali: **sodium ethanoate** and **methylamine** — the base deprotonates the acid and frees the amine.
(c) $CH_3CONHCH_3 + 4[H] \rightarrow CH_3CH_2NHCH_3 + H_2O$; the product is the secondary amine *N*-methylethylamine.
(d) In an amide the nitrogen lone pair is **delocalised** onto the adjacent carbonyl oxygen; it is therefore not available to accept a proton; in an amine the lone pair sits on the nitrogen alone, with no electron-withdrawing carbonyl beside it, so it is readily donated.