

Exercise walk-through

34.3

Amides

A-Level Chemistry

What we will cover

- 1 Amines & basicity
- 2 Phenylamine & azo dyes
- 3 Amides
- 4 Zwitterions
- 5 Peptide bonds
- 6 Electrophoresis



azo compounds are dyes

Zwitterions, and how electrophoresis separates them

a zwitterion

at intermediate pH an amino acid has a **positive** —NH_3^+ and a **negative** —COO^- , with no net charge

in acid

low pH: it gains H^+ and becomes **positive**

in alkali

high pH: it **loses** H^+ and becomes **negative**

the isoelectric point

the pH at which the net charge is zero – and it differs between amino acids

electrophoresis

a mixture is placed in an electric field **at a chosen pH**

what happens

each amino acid moves toward the electrode its charge *at that pH* attracts – and one at its isoelectric point does not move at all

The chosen pH is the whole technique. Change it and the same mixture separates differently, because each component's charge changes.

Making phenylamine, and the azo route

step 1

nitrate benzene: concentrated HNO_3 and H_2SO_4 , giving nitrobenzene

step 2

reduce it with hot tin and concentrated HCl , then add alkali – giving **phenylamine**

diazotisation

phenylamine with HNO_2 (from NaNO_2 and HCl) below 10°C gives a diazonium salt

why cold

the diazonium salt decomposes above about 10°C

coupling

the diazonium salt with phenol in NaOH(aq) gives an **azo dye**

the colour

comes from the extended delocalisation across the $-\text{N}=\text{N}-$ bridge joining two rings

Two steps to phenylamine, then two more to the dye. Naming the **temperature** of the diazotisation is a marked condition, not a detail.

Exercises 2.1·3.1

2.1 Give the two reagents used to make ethanamide.

[2]

2.2 Name the organic product of reducing ethanamide with LiAlH_4 .

[1]

3.1 Acid hydrolysis of ethanamide gives ethanoic acid and:

[1]

☐

A ethylamine

B an ammonium salt

C ethanol

D ethene

Exercises 2.1·3.1

2.1 Give the two reagents used to make ethanamide.

[2]

2.1

- ethanoyl chloride; ammonia, NH_3
-

2.2 Name the organic product of reducing ethanamide with LiAlH_4 .

[1]

2.2

- ethylamine
-

3.1 Acid hydrolysis of ethanamide gives ethanoic acid and:

[1]

☐

A ethylamine

B an ammonium salt

C ethanol

D ethene

3.1 B

- Acid hydrolysis gives ethanoic acid and an ammonium salt

Exercise 3.2

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

Exercise 3.2

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

3.2 B

- The N lone pair is delocalised onto the neighbouring C=O group

Exercise 3.3 (a)

3.3 Ethanamide is hydrolysed by hot aqueous NaOH.

(a) Name the two products.

[2]

Exercise 3.3 (a)

3.3 Ethanamide is hydrolysed by hot aqueous NaOH.

(a) Name the two products.

[2]

(a)

- sodium ethanoate and ammonia

Exercise 3.3 (b)

3.3 Ethanamide is hydrolysed by hot aqueous NaOH.

(b) Write the equation.

[2]

Exercise 3.3 (b)

3.3 Ethanamide is hydrolysed by hot aqueous NaOH.

(b) Write the equation.

[2]

(b)



Exercise 3.4

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

[2]

Exercise 3.4

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

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

Setup for exercise 3.5

3.5 *N*-methylethanamide, $\text{CH}_3\text{CONHCH}_3$, 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]

Exercise 3.5

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

[3]

Exercise 3.5

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

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)

Full solution 3.5 (1/2)

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)

Full solution 3.5 (2/2)

- With alkali: **sodium ethanoate** and **methylamine** – the base deprotonates the acid and frees the amine

(c)

- $\text{CH}_3\text{CONHCH}_3 + 4[\text{H}] \rightarrow \text{CH}_3\text{CH}_2\text{NHCH}_3 + \text{H}_2\text{O}$; 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