

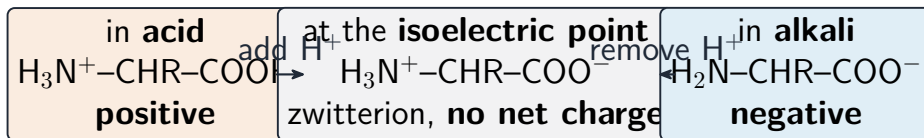
Exercise walk-through

34.4

Amino acids

A-Level Chemistry

Zwitterions



An **amino acid** has a basic $-\text{NH}_2$ & an acidic $-\text{COOH}$.

It forms a **zwitterion** (both charges, no net). It is positive in acid, negative in alkali, and neutral at the **isoelectric point**.

Peptide bonds

Two amino acids **condense** : the —OH and —H leave as water, forming a **peptide bond** (an amide link). Two give a **dipeptide** , three a tripeptide.



the **peptide bond** (an amide link)

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

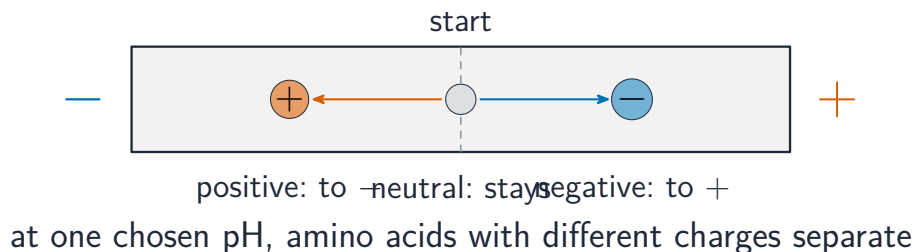
The chosen pH is the whole technique. Change it and the same mixture separates differently, because each component's charge changes.

Electrophoresis

In **electrophoresis** at a chosen pH:

- positive amino acid → the − electrode
- negative → the + electrode
- neutral (isoelectric) → stays put

So they separate.



Making amines

halogenoalkane + NH_3



an amine

reduce a nitrile (LiAlH_4)



Two routes to an amine: from a halogenoalkane, or by reducing a nitrile

Exercises 2.1·2.2

2.1 State what is meant by a **zwitterion**.

[1]

2.2 Name the type of bond formed when two amino acids join.

[1]

Exercises 2.1·2.2

2.1 State what is meant by a **zwitterion**. [1]

2.1

- an ion with both a positive ($-\text{NH}_3^+$) and a negative ($-\text{COO}^-$) charge but no overall charge
-

2.2 Name the type of bond formed when two amino acids join. [1]

2.2

- a peptide bond (an amide link)

Exercises 3.1-3.2

3.1 At a pH **below** its isoelectric point, an amino acid carries an overall:

[1]

☐

A positive charge

B negative charge

C zero charge

D double negative charge

3.2 In electrophoresis, an amino acid that is **negatively** charged moves towards the: [1]

☐

A negative electrode

B positive electrode

C neither electrode

D both electrodes

Exercises 3.1-3.2

3.1 At a pH **below** its isoelectric point, an amino acid carries an overall:

[1]

☐

A positive charge

B negative charge

C zero charge

D double negative charge

3.1 A

- Below the isoelectric point, extra H^+ gives an overall positive charge

3.2 In electrophoresis, an amino acid that is **negatively** charged moves towards the: [1]

☐

A negative electrode

B positive electrode

C neither electrode

D both electrodes

3.2 B

- A negative ion is attracted to the positive electrode

Exercises 3.3-3.4

3.3 Explain, using equations or structures, how the charge on the amino acid glycine ($\text{H}_2\text{NCH}_2\text{COOH}$) changes between low pH and high pH. [3]

3.4 Two amino acids are mixed and held at a pH equal to the isoelectric point of one of them. Explain what happens to each in electrophoresis. [3]

Exercises 3.3-3.4

3.3 Explain, using equations or structures, how the charge on the amino acid glycine ($\text{H}_2\text{NCH}_2\text{COOH}$) changes between low pH and high pH. [3]

3.3

- at low pH the $-\text{COO}^-$ is protonated to $-\text{COOH}$, giving $\text{H}_3\text{N}^+\text{CH}_2\text{COOH}$, overall positive; at high pH the $-\text{NH}_3^+$ loses H^+ to give $\text{H}_2\text{NCH}_2\text{COO}^-$, overall negative; between them lies the zwitterion $\text{H}_3\text{N}^+\text{CH}_2\text{COO}^-$ at the isoelectric point

3.4 Two amino acids are mixed and held at a pH equal to the isoelectric point of one of them. Explain what happens to each in electrophoresis. [3]

3.4

- the amino acid at its isoelectric point is a neutral zwitterion, so it does not move; the other amino acid is charged at that pH; so it migrates towards the oppositely charged electrode, separating the two